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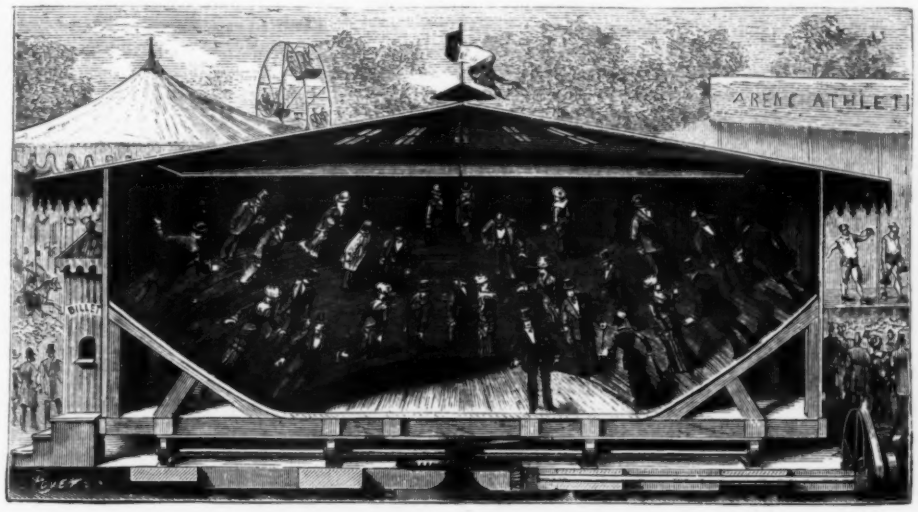
A COUNTRY RESIDENCE.

THIS new residence, situated on the Corbar Road, has been erected for Mr. John E. Harrison, of Buxton, England, from the designs of Messrs. Richard Waite and John R. Parkin jointly. The external walls to level of ceiling line on first floor are built of grit stone, obtained from an adjacent quarry, rock faced, boasted beds and joints, and boasted stone dressings and strings (not rubbed). The gables, etc., are built of rubble stone, with thin wood bricks, built in to secure laths, and faced with Parson Smith's strawberry-colored Broseley hanging tiles. The roof is covered with brindled tiles from the same works, having layers of boards and felt underneath. The chimneys are very massive, and faced with brindled bricks of a deeper color than the roof tiles from the Peel Works, Tamworth. All flues are constructed with fire clay combined smoke and air shafts; the latter having Sheringham ventilators near the ceiling of each room, and terminate with outlets with openings under the chimney caps. The departure from the almost universal stone and slate of Buxton architecture has a pleasing effect. The upper part of windows in reception rooms and principal rooms are filled with painted glass by Swaine Bourne, of Birmingham. The interior fittings are in oak and pitch-pine, the chimney-pieces being walnut and oak. A smoke room has been fitted up on the second floor, with access by a dormer at the S. E. corner to a lead flat over the drawing room window, from which very extensive views are obtained over Buxton, and some of the most picturesque Peak scenery. Mr. Nelson Webbe, of Buxton, was contractor for the works.—*The Building News.*

THE dome of the Washington Capitol is being painted, and it will take fifteen tons of white lead.

THE PLAGIOSCOPE.*

WHEN a man runs rapidly around a circus ring he is influenced by his own weight, and by a centrifugal force which tends to throw him outwardly. In order to resist this latter action he is seen to lean instinctively toward the center of the ring, so that the resultant shall pass constantly between his feet and keep him in equilibrium.

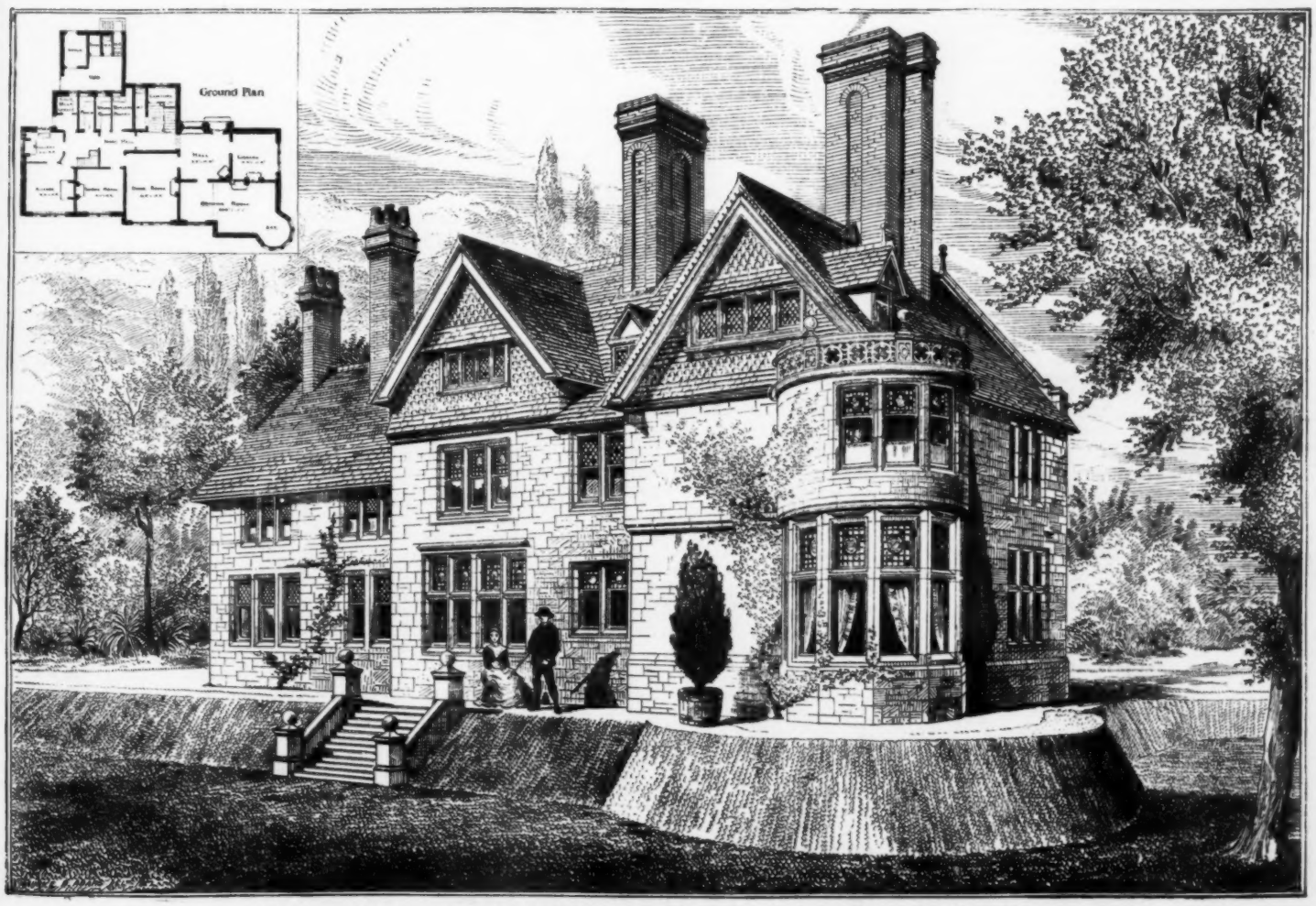


THE PLAGIOSCOPE (Vertical Section).

The man *knows* that he is moving *obliquely* with respect to the vertical, for such a position is indispensable to withdraw him from an influence that he *knows*, and that results from his *own motion*.

Let us suppose, now, that this same man is placed in a circular room closed in on every side, and into which a light filters, but which allows no external objects to be seen. Let us admit, moreover, that this room, whose floor is perfectly horizontal, is mounted on a pivot so that it can revolve very smoothly, in its entirety, around its vertical axis. The man being located at a point on the floor near the circumference, let us cause the apparatus to revolve very gently at first, and then progressively increase its speed. The man will necessarily participate in the rotary motion, but he cannot be conscious of it, since he has no external point of comparison to judge by. He is, nevertheless, under the influence of a centrifugal force which tends to throw him against the wall of the room, and it is therefore evident that while resting on the same point on the floor he will, in measure as the centrifugal force develops, be obliged to lean toward the axis, so as to bring his center of gravity on the resultant passing through his feet—the essential condition for keeping him in equilibrium. But, as he believes himself immovable and vertical, since he feels himself constantly in equilibrium, can he admit that he is oblique with respect to the vertical? He ascertains that he is no longer perpendicular to the floor, inasmuch as he is obliged to bend his knee on the side toward the center of the room, and he sees that the angles that he forms with the floor are no longer equal; but, being ignorant of his rotary motion, he will believe himself to be in an inclined position. He will imagine, then, that the entire room (floor, walls, and ceiling) has displaced itself *en masse* by rising on one side and descending on the other. If the rotary motion is such that he is obliged to lean over at an angle of 45°, it will be at this same angle that he will seem to see the floor of the room; and a person placed opposite on the same diameter as he, and at the same distance from the center, will appear to him absolutely horizontal, for such person will necessarily also stand at an angle of 45°.

* Project for a centrifugal force apparatus to produce the illusion of tumbling over.



SUGGESTIONS IN ARCHITECTURE.—A COUNTRY RESIDENCE.

If, now, our man moves over the floor, his inclination will diminish with the centrifugal force in measure as he approaches the center. At the very center, where centrifugal force is null, the floor will appear to him perfectly horizontal. If we suppose other persons in the room, it is from this point only that he can see them in their real positions, that is to say, according to the true inclinations that centrifugal force makes them assume with respect to the places they occupy.

It should be remarked that the inclinations of all these persons, whatever be their places, will converge toward the same point of the axis of rotation, and such point will rise or descend according as the speed increases or diminishes. If, instead of approaching the center, our man follows the circumference, the spectacle will become still more curious. It will seem to him as if the floor were the base of a cone lying on a horizontal circle, the apex in the center, and as if this cone were revolving under his feet in measure as he advanced, so as to leave him constantly at the lowest point.

The accompanying figure represents the *Plagioscope* (from the Greek *πλάγιος*, "oblique," and *σκοπέω*, "to see") as we conceive it in practice. The floor, instead of being horizontal, as we have supposed it theoretically, is to be slanting, as shown in the cut, so as to allow persons to keep their positions better; and the circular room is to be revolved around its axis by means of a steam mechanism.

From what we have said, it will be seen that persons in such a rotating room would be all leaning over in order to keep their equilibrium, and each of them would, in our opinion, see his opposite as if he were horizontal with respect to himself. The illusion would be extraordinary.—*E. Joyeux, in La Nature.*

GIGANTIC FLORIDA ENTERPRISES.

MR. H. C. FOREST, of the Florida Land Improvement Company, Philadelphia, also of the Atlantic and Gulf Coast Canal and Okeechobee Land Company, visited the *Lumberman* recently, and gave much information of interest concerning the companies and their operations. Mr. H. Disston, the famous saw manufacturer, is the prime mover of both concerns. It will be remembered that Mr. Disston purchased awhile ago 4,000,000 acres from the State of Florida, and by agreement he had the right to select from all State lands in bodies of 10,000 acres or more. Soon after Mr. Disston bought these lands he disposed of half of them to foreign capitalists, retaining, as a matter of course, the better half. The State owned at the time of the purchase about 16,000,000 acres. In selecting the land Mr. Disston paid particular attention to the timber upon it, and secured about 500,000 acres of woodland, principally yellow pine.

The greater part of these 500,000 acres lies toward the northern coast, in Hillsborough, Hernando, and Sumter counties; there are also some of them in La Fayette and Suwannee counties. The Suwannee and Withlacoochee rivers run through these lands, and in time they will be traversed by five railroads that are projected. There are good ports along the coast, and the lands, Mr. Forest informs us, can be bought in large bodies at from $3 to $5 per acre.

In the lower sections of Polk, Sumter, Hillsborough, and Manatee counties the soil is well adapted to tropical fruit, and is considered very valuable. Orange growers in the more northern portion of the State are gradually going farther south in order to get below the frost line. These lands can be utilized every month in the year. Three crops of vegetables can be raised in the twelve months, and it seems to be just the place where a lazy man can get along with the least possible wear and tear upon the conscience.

The influx of people is astonishing, and in some of the towns, in many instances, they have been turned away for lack of accommodations.

The Atlantic and Gulf Coast Canal and Okeechobee Land Company has for its mission the reclaiming of the overflowed lands of Florida. According to its contract with the State, its operations are confined to the territory north of township 28, and east of Peace River—a territory some 80 miles wide and 200 miles long. By virtue of the agreement the State gives the company an acre for every acre reclaimed.

In the spring of 1881 Mr. James M. Kramer, the engineer of the company, and said to be one of the most competent, visited the overflowed country in Florida to devise a method by which the land could be made valuable. He found by surveys that Lake Okeechobee lay some twenty odd feet above tidal influences, and that it served as a sort of reservoir without any outlet, and, during rainy seasons, overflowed.

The object is to relieve this lake of its surplus water, and thus prevent its spreading over the surrounding country. To this end canals will be cut, one from the east side of the lake striking the St. Lucie River, which empties into the Atlantic, and another from the west side of the lake, leading into the Caloosahatchee River, emptying into the Gulf of Mexico. The length of these canals will be nine and a half and twenty miles respectively. On the west side canal a dredge boat has been in operation for the past nine months, and has cut eight miles of canal. The dredge lately penetrated Lake Hickpochee, and is now working on the strip of land between this lake and Okeechobee, and it is expected that the last named lake will be reached in November. The fall from Lake Hickpochee to Fort Thompson is 16½ feet, giving a current of three miles an hour.

The dredge is one of Menge's patent, 75 feet long and 20 feet wide. Over the beam runs an endless chain, to which a number of buckets are attached. The dredgings are raised about 25 feet and dumped into scow boats, when they are landed and used for fertilizing purposes. The machine cuts a channel 22 feet wide and 6 feet deep, and can cut 1,700 feet in ten hours, although the average is 550 feet.

The country north of Lake Okeechobee, embracing the rich bottom lands of the Kissimee Valley, slopes from the north, and is 22 feet above tidal influences. There is now a dredge working at the head of Lake Tohopokaliga, which will work southward and clear away all obstructions between that point and Lake Okeechobee. Lateral canals will be cut leading into the Kissimee River for the purpose of draining the surrounding country. At the head of Tohopokaliga Lake, at the terminus of the South Florida Railway, is a new town called Kissimee City. It has fifty houses, two good hotels, and supports a newspaper. The place is said to present a thrifty and enterprising appearance.

In addition to heavy crops the soil is adapted to mango, sugar apples, pineapples, cocoanuts, etc. The cocoanut industry is a new one, and has not received attention for more than about eight years. The trees mature in six years, and a tree when matured produces a nut every day in the year. The hull, from which cocoa matting is made, pays all expense of cultivation. It is the opinion of many that this industry will be one that will grow rapidly and pay handsomely.

Jute, as probably nearly everybody knows, is raised in India. The trade in it is immense, and the officers of the company, in consideration, thought that possibly this country might have some of it to itself. They sent to Calcutta for eight bags of jute seed, and distributed it to planters in the State. It has now been planted six months, some of it is five and six feet high, and most of it is looking splendid.—*N. W. Lumberman.*

AMERICAN CHEESE IN ENGLAND.

IN England cheese-making has long been a stationary art. The farmers have kept to the old paths. The Americans, on the contrary, have advanced, with all the customary energy of their race. Those who remember the first importations of American cheese will find little cheerfulness in the recollection. The first consignments came in large barrels, and were only a degree less objectionable in appearance than repellent in flavor. To the American cheese of the present day they bore much the same relation as did the tough rolls of "jerked" beef which were sent over from Texas about twenty years ago to the fine, healthy-looking quarters which are now regularly supplied to the English market. To the Exhibition of 1862, however, the Americans sent a monstrous cheese which was intended as a gage of battle. Thenceforward every consignment improved on the last in appearance and quality, until, at the present day, their best varieties, when stripped of the cloth which surrounds them, and cut in two with a blunt knife or a piece of string, may easily be mistaken for excellent Cheddar. It is said of the Lancashire cotton operatives that they prefer American cheese to any other. There are two reasons for this preference: American cheese is cheap, and it is "mild." The poorer classes of Englishmen are no fonder of "strong" cheese than of "high" game. They do not appreciate that biting of the tongue which is produced by Roquefort or old Stilton. The extremely mild Gouda, or Dutch cheese, has only failed to become popular because it is too salt, and because when toasted it is apt to assume the appearance and the consistency of leather.

In the matter of flavor, American cheese, manufactured as it is at present, is never likely to compete successfully with our own dairies. There is a pleasant individuality about all kinds of English cheese. Each country has its own method of manufacture. The Americans make their cheese in factories. If fifty cheeses are turned out at one making, they will all be exactly alike in shape, and size, and color, and flavor. Now, in six cheeses coming from a Cheshire dairy, there will be six varieties of taste. For long after it has been made an English cheese is crisp and crumbly, and retains the taste of the curds. Then it begins to knit together and to mellow; it improves with keeping, and only gets a really rich flavor after it has a year or so of age. American cheese, on the other hand, is made in a place almost as large as a cotton mill; it is ripe almost immediately after it has been taken from under the presses; and by long keeping it usually grows bitter and dry. It has been proposed that, in order to compete successfully with America, the farmers of a cheese-making district should, instead of keeping separate dairies, "club together" in one great factory, after the transatlantic model. The problem to be solved is whether this can be done without sacrificing the peculiar characteristics of English cheese. The English dairy farmers have at present the satisfaction of knowing that, despite outward appearances, they can, if they choose, produce a really superior article. Whether American cheese is made of skim-milk and fat or not, the best qualities are sold by retail dealers at from twopence to threepence a pound less than good Cheddar. This margin certainly ought to be large enough to encourage the effort to revive cheese making in England, unless, indeed, as is not improbable, the farmers can do better with their milk by sending it to the large towns. In any case, however, we are not likely to produce as much cheese in England as will appreciably diminish the amount of our imports. English cheese is a luxury for the prosperous few; to the many thousands poor men who have "little to earn and many to keep," American cheese is by no means the smallest of those boons which we receive, with rather a bad grace, from our cousins on the other side of the Atlantic.—*Pall Mall Gazette.*

A NEW MEXICAN RANCH.

A CORRESPONDENT of the *N. Y. Tribune* has been visiting the ranch of Don Rafael Romero, at La Cueva, New Mexico. The village has a population of nearly three hundred, mainly the families of the eighty employes of the estate, which covers 40,000 acres. Ten thousand acres are irrigated, half under the plow and half reserved for meadow lands. Then there are 5,000 acres of timber land, 5,000 acres of mountain pasture, and a stock range of 20,000 acres, which is to be fenced in. In this Brobdingnagian farming, irrigation, as everywhere in New Mexico, is an important and interesting feature. The character of the ground, which rises gently from the valleys of the Mora and two other little streams on the estate like the prairie swells of Western Kansas, is highly favorable to the carrying of irrigation ditches. The system embraces fifty miles of ditches and three artificial lakes, the largest three miles in circumference. Where the Mora enters the head of the valley there is a strip of meadow golden with sunflowers, stretching down between a stony pine clad ridge and a gray cliff. In this is the cave—La Cueva—which gives the ranch its name, and which was a favorite resort for the Indians who came down for the trout with which the Mora is still filled. A little below this cliff, near the mill which it furnishes with water, begins the main irrigating ditch, nine feet wide and from four to six deep. From this, as from the other large ditches, side trenches with gates supply the fields along the upper side of which they run. The main ditch yields water to the largest of the three artificial lakes.

The lakes have been utilized not only for a water supply in dry weather, but for a business novel in the Southwest—pisciculture. These lakes contain great numbers of suckers, which are excellent food, and trout. Lately Don Rafael has procured a quantity of carp eggs from Washington, and is trying the experiment of raising carp. Fishing is conducted on a scale corresponding in magnitude to the other farming operations. A large seine is sunk in the lake, mules harnessed to the ends, which are carried on shore at either end, and the seine thus dragged through the water, lifting out fish by the barrelful. This season the value of the fish, principally suckers, sold from these lakes amounted to $1,000.

The chief product of the farm is wheat, which covers the larger half of the 3,500 acres on which crops were growing this year. This is thrashed out by a thrasher of ten horse-power and ground into flour in Don Rafael's mill. The average yield is from twenty-five to forty bushels per acre, while oats yield sixty and barley seventy. This is a stock ranch as well as a farm, and Don Rafael intends to fence in his range of 20,000 acres and increase the number of his stock. There is an opportunity also for him to take up another pursuit, for, as is the case near the main range throughout New Mexico, there are outcroppings of copper and silver ore in the mountain land upon the estate.

The enterprising owner of this vast estate is a native of the Territory, a graduate of Princeton College, and last year was Speaker of the Territorial Legislature.

THE LATE DR. D. VAN MONCKHOVEN.

IN the death of Dr. D. van Monckhoven, whose untimely decease, at a comparatively early age, we briefly recorded last week, photography and kindred sciences sustain a very serious loss. Confining himself to no particular branch of photography or of science, the deceased was emphatically what is termed an "all-round" man, being equally at home in chemistry, photography, optics, astronomy, and spectroscopy. To give anything like an adequate account of the labors of such a man is obviously impossible within the limits of the space at our disposal. In the following record of his life we shall, therefore, confine ourselves as closely as possible to his connection with photography.

Desire Charles Emmanuel van Monckhoven was born at Ghent, on the 25th of September, 1834, and had thus just completed his forty-eighth year on the day of his death. Though we have but few details of his earlier life, it is evident that he must have turned his whole attention to scientific pursuits at a very early age. Originally a chemist, he was attracted by the then new art of photography; and, though it is impossible to fix the exact date of his accession to the photographic ranks, it is certain that he has left his mark on its literature as far back as nearly thirty years ago, his *Traité Générale de Photographie* having reached a second edition early in 1856, when he was in his twenty-second year. At that period the name of Van Monckhoven was familiar to the readers of *La Lumiere, Cosmos,* and *La Revue des Deux Mondes.* Subsequently he became an occasional contributor to our columns, as well as to those of *Le Moniteur de la Photographie* and *Le Bulletin Belge,* his first appearance in English literature being in this journal—then the *Liverpool and Manchester Photographic Journal*—in 1858.

In the interval between the publication of his *Traité Générale*—which ran into several editions and was translated into English—and his death, Dr Monckhoven was the author of an immense number of pamphlets and works of a technical character, those best known to English photographers being the *Traité Populaire de Photographie,* which followed the *Traité Générale,* in 1862, and was published in English by Messrs. Horne and Thornthwaite, and his work on *Photographic Optics,* which appeared in its English dress late in 1867, or early the following year. So recently as a few weeks ago we received from him probably the last publication which left his pen, being an account of the results of some researches on the hydrogen lines of the spectrum.

Dr. Monckhoven was well known to the Photographic Societies of London, France, and Vienna, at all of whose meetings he read papers. At the February meeting in 1863 he communicated to the London Photographic Society a paper on *A Theory of Photographic Processes,* and in June of the following year he described to the Photographic Society of France his new enlarging apparatus. In October, 1869, at Vienna, and in December of the same year in London, he read papers on a *New Artificial Light for Enlargements,* and described an improvement on the Drummond lamp. In the following November he gave to the Vienna Photographic Society an account of a further improvement he had effected. Again, at Vienna, in 1871, he described a *New Dry Process* based upon the employment of a collodion containing silver nitrate, which was sensitized by immersion in a bath of potassium bromide, and subsequently washed and treated with a preservative in the ordinary manner. *A New Method of Preparing Collodion* was also given to the Vienna Society. This consisted in the employment of what was afterward termed "precipitated cotton;" that is, pyroxyline thrown down from its solution in ether and alcohol by means of water, the result being a perfectly soluble product quite free from impurities. After an interval, during which he appears to have turned his attention to carbon printing, we find Dr. Monckhoven reading a paper before the Photographic Society of France, in 1876, *On the Effects of Acids and Alkalies in Carbon Printing;* and two years later, before the Photographic Society of Great Britain, he read a paper *On the Fading of Carbon Prints,* in the course of which he mentioned the curious fact that carbon tissue sensitized with citrate of iron and ammonia, exposed under a negative and afterward immersed in solution of potassium bichromate, gives on development an image in the usual way, which is not the case if the bichromate be omitted.

For many years Dr. Monckhoven gave considerable attention to enlarging, his solar apparatus having been introduced in 1864, and his improved artificial light arrangement in 1869. But it was not only in the optical and mechanical branches of enlarging that he interested himself; on the contrary he did much to improve the methods of printing, and, though not the actual introducer, was one of the strongest supporters of nitro-glucose paper for enlarging purposes.

Of late years Dr. Monckhoven has done less in writing than formerly, his time having been fully occupied in the management of an extensive business that had grown under his hands. Some years ago he embarked in the manufacture of carbon tissue, and so thoroughly did he enter into this business that, in order to secure the quality of product he considered necessary, he was compelled to erect a factory for the manufacture of gelatine. More recently he has added the manufacture of dry plates and emulsions to his other industries; and the fact that his tissues, plates, and emulsions are in great demand on the Continent sufficiently proves the care and excellence of their manufacture.

Gelatino-bromide workers of the present day will recollect Dr. Monckhoven chiefly on account of his ingenious method of emulsification, by means of which the necessity for washing the emulsion is dispensed with. This process, which was published in 1879, consists in precipitating the silver in the form of carbonate, which, after washing, is incorporated with the gelatine solution, and converted into bromide by means of hydrobromic acid. It should also be borne in mind that, though others have tacitly claimed the credit, Dr. Monckhoven was the first to use ammonia for the purpose of giving sensitiveness to a gelatine emulsion without heat or prolonged cooking. He also distinguished between the different modifications of silver bromide, specially designating the "green bromide" as the sensitive form. These original discoveries of his have, after publication, been fully recognized as correct.

As we have said, Dr. Monckhoven did not confine him-

self to photography; and, despite the cares of an extensive business, he found leisure to devote to his favorite studies—astronomy and spectroscopy. His residence in the Rue de l'Hopital was provided with an elaborately-fitted observatory, in which the deceased spent many of his hours of relaxation

Probably few men in connection with photography have been so widely known in all parts of Europe and the world as Dr. Monckhoven; and his loss will be mourned no less by the large circle of his scientific and personal friends than by his immediate relatives. He leaves a widow and two daughters.—*British Journal of Photography.*

AERIAL NAVIGATION

AT the recent meeting of the American Association. Mr. W. H. Lynch read a paper on "The Future of the Balloon as a Practical Means of Aerial Travel." He said that the two systems of aerial navigation, by utilizing the flying principle, are quite opposed to each other. In the flying machine, the wings or propellers are required to act upon the air to at once lift the dead weight of the machine, and to propel it or direct its course. The balloon, on the contrary, is itself a lifting power, lifting itself and carrying foreign weight that may be a force to direct or propel it. To make fly a machine that is heavier than the air, there is needed to merely lift it a greater part, if not all, that it can carry of the weight of force necessary to affect or effect its motion. A machine that is lighter than the air will at least rise of itself and carry more or less surplus weight of force that may be required to make it do something more than merely rise. We do not forget that the self-lifting machine is in one respect at a disadvantage with the inert or dead weight machine. To be lighter than air means to be bulky and to offer in motion great resistance to the air, while what is heavier than air is more compact and its motion more easily caused or directed. This one advantage of the flying machine over the balloon counts, however, but little, so long as it cannot both lift itself and carry the little extra weight of the force required to propel it. The balloon will carry no mean weight besides its own, possibly passenger or freight weight, and the extra weight of a force that may direct or even propel the whole. Strange to say, the principle of the flying machine, that has never given any practical results in aerostation, and indeed has given little or no promise of future practical results, seems for some years to have been more in favor of scientists than has been the balloon principle, from which most important, not to say exceedingly promising, results have been obtained. When it comes to serious suggestions of possible means of future aerial travel, confidence in science, inventive talent, and mechanical skill is lost, and he who is sanguine of the future is by many of the good and wise looked upon as a fit subject for mild ridicule. In answer to the question, From which principle may the best results be expected? we may note that the dead weight principle has given no promise that we shall get from it, alone at least, any practical result. The balloon principle has already given us so much that no one may positively negative the opinion of Glaisher, that it is the "first principle of some aerial machine that remains to be suggested."

The peculiar disadvantage of the balloon, that of bulkiness, may be minimized, and the flying principle itself may doubtless be utilized to its full value in its application to the direction or propulsion of the balloon. There has been almost no progress lately in this matter. The fact that little has been accomplished here, while there has been great advance elsewhere, is taken as a proof that little may be looked for, but we think this a mistaken supposition. The growing interest and faith in the future of aerial travel is well seen by the attention paid lately by scientific journals to the question. As societies for the advancement of aeronautics have been established in Britain, America, France, and other countries, there is reason to believe that our knowledge of this most difficult department of science will be more extensive in the near future, and he believed that aerial navigation would yet become a success.

ARGAND LAMPS.

THE Argand lamp was invented by Dr. Aime Argand, a Swiss physician and chemist, who died in 1803. According to the *Pottery and Glass Reporter*, it consists of two concentric cylindrical tubes, between which is fitted the annular wick used in its peculiar burner. The annulus inclosing the wick is closed at the bottom, and communicates, by a pipe, with the oil reservoir. The interior tube being open, free access of air is allowed to the interior and exterior of the flame, insuring more equal and perfect combustion.

In a round solid wick, burning any of the fatty oils, such as sperm, a large proportion of the carbon, which in that class of oils is greatly in excess of the hydrogen, escapes unconsumed and is wasted, rising in the form of smoke.

The annular wick has double the surface of a solid one of the same diameter exposed to the contact of the atmosphere, and as the flame is also thinner its temperature is more uniform, and the vapor from the center of the wick is consumed equally with that from its exterior. The combustion is also greatly aided by the draught caused by the glass chimney, continually bringing fresh supplies of oxygen in contact with the flame and protecting it from currents of air. The chimney was invented by L'Ange.

A French mechanic, named Carcel, patented an improvement in 1800, in which the oil is pumped from the reservoir to the wick by power derived from a spring, or by the ascending column of air above the chimney. This is called the mechanical lamp, and is used in the large lamps for the dioptric system in lighthouses

The Argand burner, as modified by Fresnel for the dioptric system in lighthouses, has four concentric wicks, the outer one 3¼ inches in diameter, and the great heat produced is carried off by two means—overflowing the wick with oil, and by means of the ventilator devised by Faraday. The oil in superabundant quantity is pumped into the wick tubes and overflows over the top. The ventilator is a tube having several sections, the lower portion of each being flaring, and receiving the upper end of the section below, which enters it a short distance. The top of the lamp chimney enters the lower section and produces a great draught.

The Argand lamp first made effective the catoptric system for lighthouses.

In Dopp's Argand lamp the tubular wick burner has a water chamber interposed between the wick tube and the oil reservoir, so as to prevent the heating of the contents of the latter. The wick occupies an annular space formed by two concentric tubes. There is a deflector plate to reflect upward the heat which reaches the inside of the tube, and a perforated floor to prevent the conduction of flame, on the principle of Sir Humphry Davy's safety lamp. The water has an overflow down the central air tube.

The Argand gas burner has a circular series of holes on the upper edge of a cylindrical chamber, having a central aperture to allow access of air to the inside of the flame.

The jets from the series of holes unite to form a cylindrical flame. The holes are about one-sixth of an inch in diameter, and when there are ten holes in the circle the middle opening will be four tenths of an inch in diameter; with twenty-five openings, the central aperture will be about one inch in diameter.

The student's lamp is a form of Argand-burner lamp, with an elevated self-flowing reservoir. When the oil chamber is lifted, the ball valve closes the aperture. As the oil burns away, bubbles of air enter the reservoir by means of a hole and allow oil to escape in limited quantities.

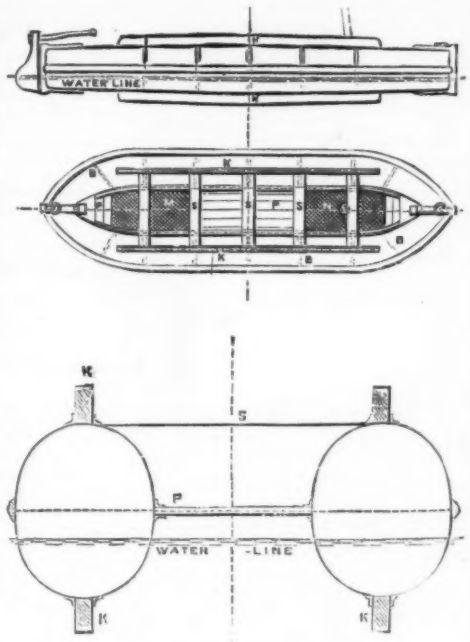
The astral lamp is akin to the Argand. It has an annular oil vessel connecting by two pipes with the wick tube, the latter being on the summit of the pedestal. It is designed to obviate the interception of light by the oil reservoir, which when placed centrally casts a shadow on the table.

The oil is contained in an annular chamber surrounding the burner, which is of the Argand kind, and the lower part of the chimney, and thence descends to the foot of the wick through two tubes.

It will be seen that the downward rays of light from the burner are not at all intercepted in the immediate vicinity of the lamp, except by the two small oil pipes, and they are not materially interfered with within a radius beyond which the light would be insufficient for reading or working by; even this is obviated in a considerable degree by a ground-glass globe surmounting the annulus, which diffuses and equalizes that part of the light which is not cast downward. The chimney assists combustion, and carries off the volatile products thereof.

IMPROVED LIFE BOAT.

TIMMIS & HODGSON, Great George Street, Westminster, make a life and ship's boat which we illustrate herewith. The boat is made in halves, top and bottom, and each has a deck, and both are alike, with keels, etc., complete. It can be launched either side uppermost, and the two halves are hinged together along one side. The top side can be turned back and the two halves make a raft. In the engraving, B B are water-tight bulkheads; K, keels, and, or, gunwales; S, seats; P, deck planking; N, deck netting, through



TIMMIS & HODGSON'S LIFEBOAT.

which any water that is shipped runs. It is claimed that the boat will sail, row, and paddle, and reference to the engravings will show to how many purposes the boat can be put. It is made of 13 B. w. g. steel, has numerous bulkheads, and can be launched into the sea if necessary without davits.

IRON-CLADS IN BATTLE.

THE German Vice Admiral von Henk, in a recent article on the value of iron-clads in battle, points out that the introduction of shell guns, soon after 1850, much diminished the value of Nelson's battle ships, with 80 or 100 guns. The necessity of protecting ships of war better against artillery became still more urgent when the introduction of steam made their construction more complicated and thus increased their vulnerability. In the Crimean war the Russian shells did great execution on ships Opinions differed greatly, however, especially in England, as to the value of iron-clads and the necessity of their introduction, until the fight of the Confederate ship Merrimac with the wooden ships of the Union in Hampton Roads, and her fight with the Monitor, placed the great superiority of iron-clads beyond a doubt. On the 8th of March, 1862, the Merrimac attacked four wooden frigates and completely destroyed two of them.

Next day she unexpectedly met the iron-clad battery-ship Monitor, a mere dwarf in comparison, and was compelled to retreat, severely damaged. The impression made by this fight was enormous, and it showed two things—the necessity of iron plating for battle-ships and of arming them with guns of large caliber and great piercing power. The first opportunity of estimating the value of iron-plating in a conflict, ship to ship, on the high seas, was afforded by the battle of Lissa on the 20th of July, 1866. In that action the relations between armor and guns were about the same as they are now. Seven Austrian iron-clads were opposed to eleven Italian. The armor of the ships was pretty equal in strength on both sides; the Italians were stronger in artillery. The result is well known. Deducting 630 who perished with the Re d'Italia and the Palastro, the Italians lost only 110 men out of 5,000. The total loss on the Austrian side was 33 killed and 124 wounded out of 7,000, the loss on the unarmored ship Kaiser being 22 killed and 82 wounded, that is, two-thirds of the whole. The battle of Lissa was an eloquent advocate for the incipient system of iron-plating ships of war.

In the war in South America in 1877 two unarmored English ships had difficulty in repulsing the attack of the Peruvian monitor Huascar, and had in the end to let it go unmolested. Of that new, malignant, and deceitful weapon the fish torpedo, we have as yet no experience, for the published reports of the Russo-Turkish war are so untrustworthy that one can found no opinion on them. The result of observation up to this date may be condensed as follows: first, unarmored ships cannot maintain a fight of any duration against the heavy guns of ships and forts; secondly, iron-plating is still an effectual defense against the heaviest guns, and consequently indispensable for battle-ships; thirdly, rams and torpedoes are, indeed, formidable weapons in sea fighting, but cannot supersede artillery as the chief weapon, and they promise more chance of success in iron-clads (because of their better protection against the enemy's artillery) than unarmored ships.

GERMAN RAILWAY SIGNALS.

RAILWAY crossings are only too often the scenes of accidents, due, in the majority of cases, to the ignorance of the gate-keeper as to the approach of a train that is behind time, or of one that is not doing regular service. It will be readily seen, then, how great is the utility of apparatus designed to prevent such accidents, by putting the guard in communication with the stations between which is located the passage committed to his charge.

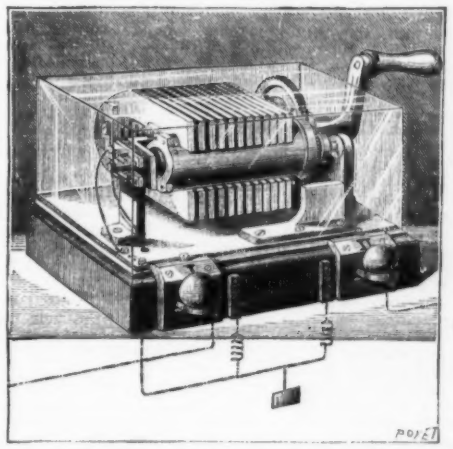


FIG. 1.—SIEMENS' APPARATUS FOR PRODUCTION OF THE ELECTRIC CURRENT.

There have, for several years past, been employed safety-apparatus of this kind, principally in Germany and Austria, and for that reason called German bells. We shall give a short description of one of these, and then point out the various uses that may be made of it.

The apparatus consists of a large bell whose hammer is moved by a clockwork movement that may be thrown into and out of gear from a distance by means of electricity. In the Siemens type the current is produced by the aid of a

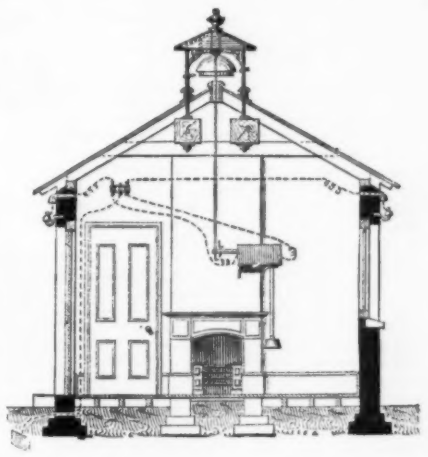


FIG. 2.—ARRANGEMENT OF THE BELL AND SIGNAL HOUSE.

small electro-magnetic machine or *inductor*. A Siemens bobbin is placed between the poles of a series of juxtaposed iron horse shoe magnets, generally about twelve in number. By turning a winch this bobbin is revolved on its axis (Fig. 1), and, through the use of gearing wheels, makes 13 revolutions to the winch's one, this corresponding to the production of 26 currents, alternately positive and negative. These currents, sent into the line wire, actuate the bells in the following manner: The polarized armature of an electro-magnet is alternately attracted and repelled, as a consequence of the reversals of the current; and it carries a scapement which gears with a toothed sector affixed to the extremity of a lever. This latter, under the influence of a spring, is then gradually displaced until it reaches a point where it ungears the clockwork that actuates the hammer of the bell (Fig. 2).

These bell apparatus are located at stations, one for the up direction and another for the down; at railway crossings; and, in general, at all dangerous points. The moment a train leaves a station, an employé who has the matter in charge turns the winch of the inductor so as to send a current to ring the bell of the station and those of the railway crossings as far as the next station; and the gate-keepers are thus warned of the approach of the train.

But the rôle of these apparatus does not find its limit here, for they may also be employed as true telegraphs to permit

track masters to signalize accidents and ask for help from the stations, or receive instructions from the latter. Let us suppose, for example, that one turn of the winch produces two strokes of the bell; then, by making a certain number of turns, with an interval between each, there could be produced any such signal as might be desired, for example:

00 *Train coming up.*
00 00 *Train going down.*
00 00 00 00 00 00 *Stop all trains.*

As it would require great attention in order to catch signals that were somewhat complicated, and as these signals leave no sensible traces, the following improvement has been devised.

Each gate-keeper has in his possession a certain number of disks, having cams on their circumferences, and containing a square hole to allow of their being mounted on an axle in the bell apparatus. Each one of these, moved by the clockwork, is capable of transmitting a special signal on the interruption of a current furnished by a local pile, and of repeating it until the motion of the clockwork has been stopped. The station employé, warned by the noise of the bell, can then receive the signals in characters by introducing into the circuit of the apparatus a Morse registering apparatus. The long and short cams of the disk of which we have spoken produce, by interrupting the current, the ordinary dots and dashes of the Morse alphabet.

Finally, as may be seen, the bell apparatus may serve as a block system; for the track masters, on hearing two contradictory ringings, may stop all trains by ordinary signals. The P. L. M. Company applies the Leopolder system in this way on its single track lines. This system differs only in some details of construction from that of Siemens, just described, the electro-magnetic apparatus being here replaced by a Meidinger pile. Calls for help are made by means of a commutator placed under a plate sealed with wax. To make use of it, the seal must be broken.

FIRELESS LOCOMOTIVES FOR TRAMWAYS

By G. LENTZ, Director of the Locomotive Works, Hohenzollern, near Düsseldorf.

WITHIN the past few years a very considerable increase has taken place in the construction of steam tramway lines in both Italy and Holland, and these lines are constantly being added to, almost to the exclusion of railways on the old system, which they seem admirably adapted to augment and even replace in many instances.

These cheap means of communication add largely to the value of agricultural products, and are a great boon to the commercial population also, providing as they do ready and cheap transport of goods from the smaller hamlets to the larger commercial centers.

In both these countries the highroads are, in a very liberal spirit, placed at the disposal of the tramway companies, and the latter have, therefore, not to spend large sums of money in acquiring the necessary land for the line; since, moreover, station accommodation is generally provided in hotels, restaurants, or inns, their chief expenditure is for repairing works and sheds, and the land they are built on. By building these sheds as simply and cheaply as possible, large first outlay is avoided, and the financial success of the undertaking materially assisted.

Against these advantages we find, on the other hand, very high working expenses; to avoid smoke expensive coke only can be used for fuel, and this on the small grates cannot be advantageously burned, and steam is thus expensive. Costs for repairs are also heavy, and increase year after year with the continued wear and tear of machinery; a large number of hands are necessarily employed in working, cleaning, and repairing a large number of small locomotives, the wages for which figure as heavy items on the balance sheet.

Another source of considerable expense to the owners of steam tram lines is that of flying sparks causing conflagrations, for the damage of which the company are, of course responsible.

Many of these serious disadvantages of small locomotives on tram lines can be completely obviated by the adoption of fireless locomotives. In large stationary boilers steam is produced of about 240 lb. pressure; the reservoir taking the place of the boiler on these fireless tramway locomotives is then filled three-fourths with water, connected to the steam space of the stationary boiler, and steam admitted till the pressure is equal in both. In stationary boilers suitably constructed, any class of fuel, such as coal, wood, peat, straw, or sugar-cane may be advantageously used.

The fireless locomotive, of which we give an outside elevation, and cross and longitudinal sections, is one of a type of which a considerable number are being built by the Locomotiv Fabrik Hohenzollern, for Java. They are constructed with inside frames and inside cylinders; the wheels are four in number and are coupled. The reversing gear is of the Joy type. The steam or hot-water reservoir rests on two cross stays connecting the longitudinal frames of the engine; it is a plain cylinder with bulged ends and a dome. On reference to the sections it will be seen that steam is taken from the dome of the reservoir through a perforated copper pipe leading into a reducing valve where the pressure is reduced to 100 lb. per square inch, and the steam is then conveyed through a pipe of large diameter which passes through the water space of the reservoir and through the bottom where it divides, a branch leading to each valve-box. On reference to the longitudinal section it will be seen that a steam trap is formed at the termination of the large steam pipe, a smaller pipe leading some distance up into it, and very dry steam is thus obtained for the cylinders. This arrangement offers no doubt considerable advantage over the steam supply of ordinary small locomotives where frequently a large percentage of water is carried over into the cylinders, particularly when the boilers are worked hard.

The steam reservoir of this tram engine is carefully protected by means of sheet iron, layers of felt, and air space from loss of heat by radiation, and it has been found by experience that the loss in pressure amounts to from 3½ lb. per hour in summer to 7 lb. per hour in winter.

The arrangement for admitting high-pressure steam into this boiler or reservoir is plainly shown in the sections. A valve, fitted with a coupling for connecting a flexible hose, is fixed to the back end of the boiler, and a steam feed pipe enters the boiler and extends down to the bottom, where it enters a perforated pipe placed along the bottom of the boiler. When steam is admitted a considerable ebullition takes place, all the water is evenly heated through, dead water cannot lodge anywhere, and the boiler is, therefore, not liable to much wear and tear, and will last many years, while the small tubular boilers of locomotives are difficult to clean and repair, often badly fired and maintained, and, while only lasting from five to eight years, cause heavy expenditures for repairs even during this time.

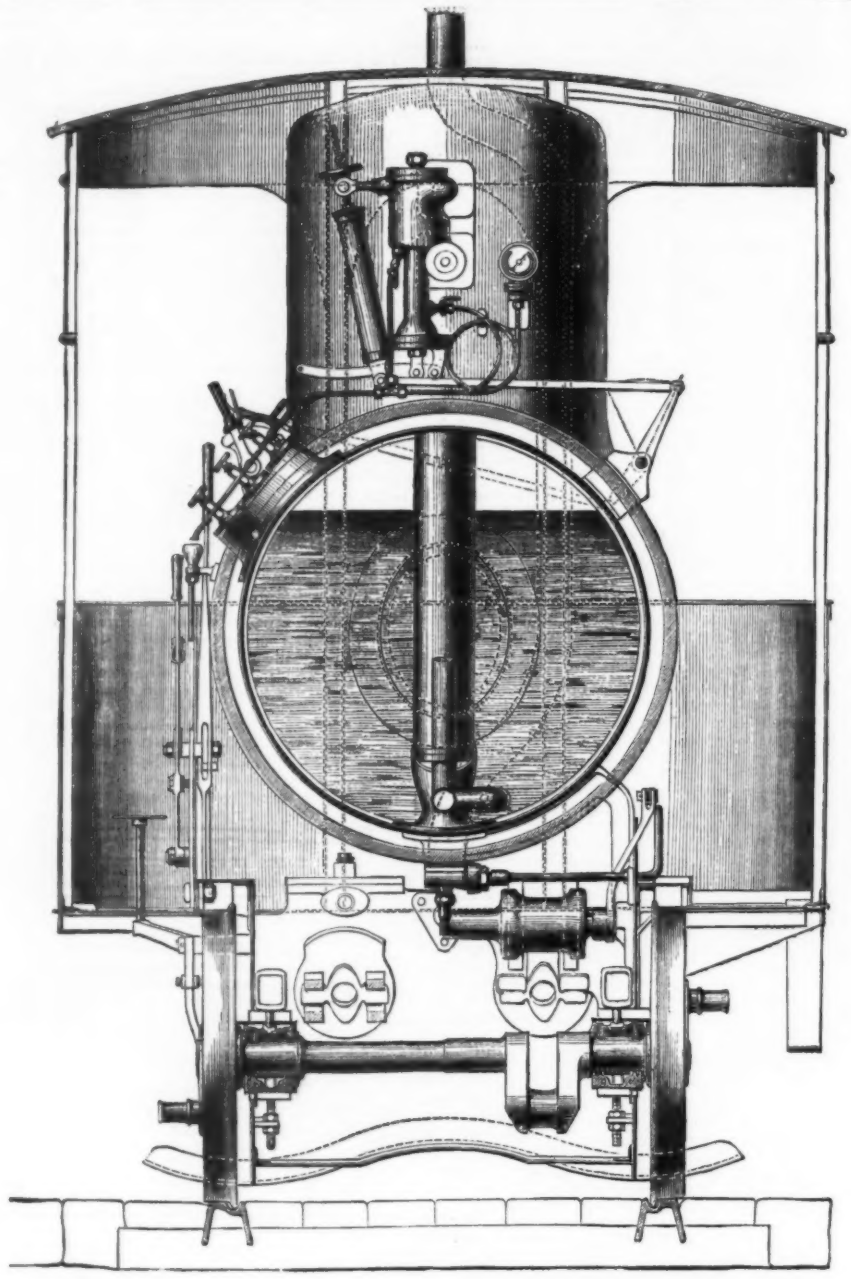


FIG. 4.

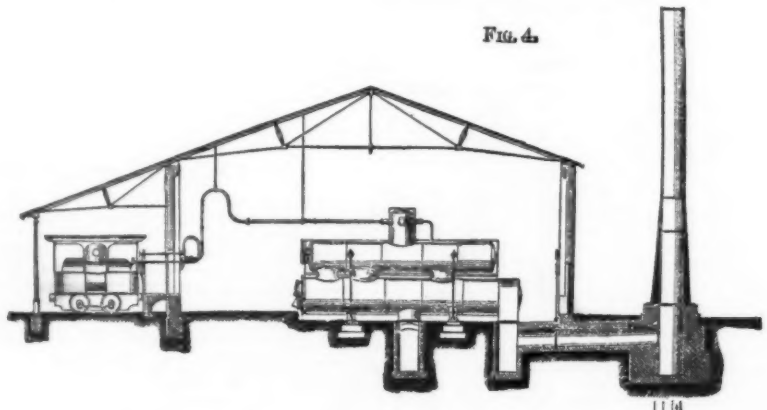
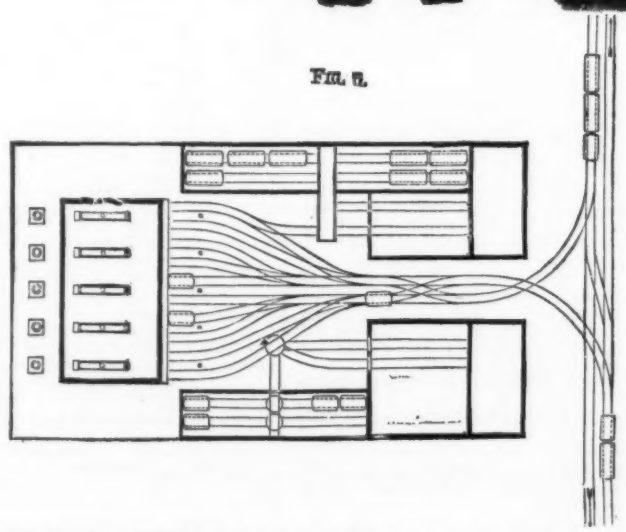
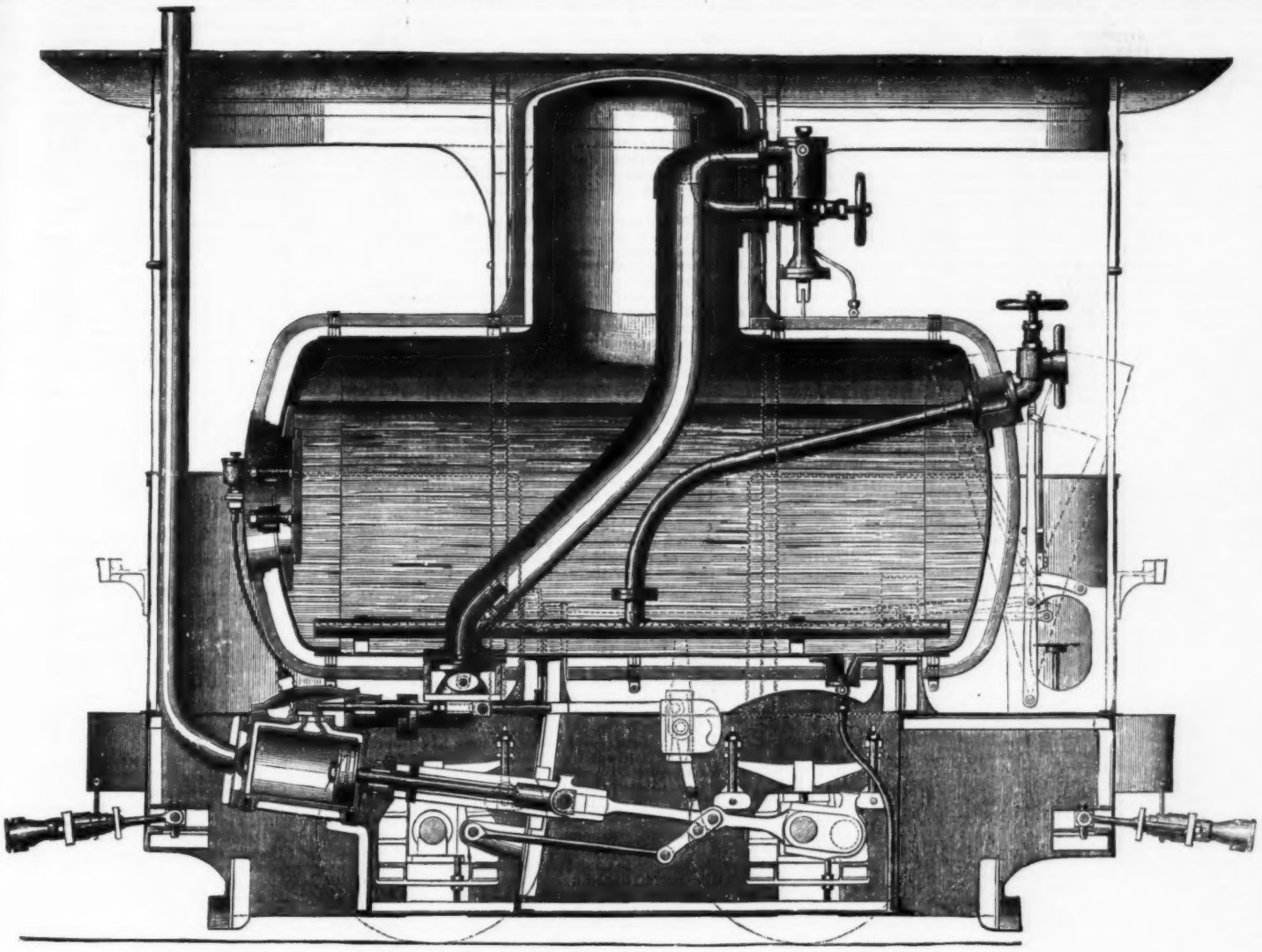


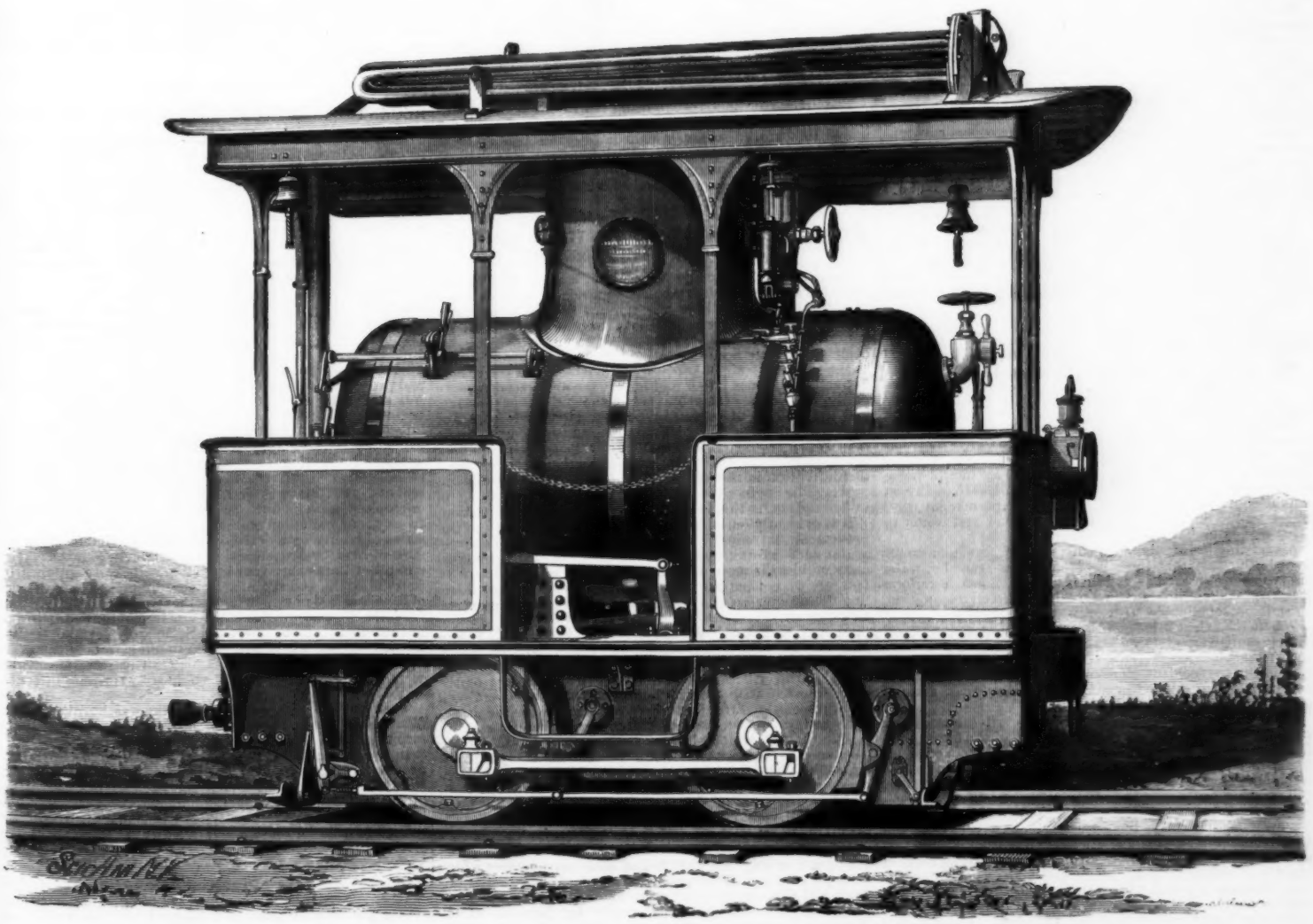
FIG. 5.



IMPROVED FIRELESS TRAMWAY LOCOMOTIVE.



IMPROVED FIRELESS TRAMWAY LOCOMOTIVE.



IMPROVED FIRELESS TRAMWAY LOCOMOTIVE.

In Fig. 4 we illustrate a section of the stationary boiler house, showing the flexible hose connection to the tramway engine, while Fig. 5 represents a plan on a smaller scale of a boiler plant and changing station, showing the arrangements of sheds, rails, and sidings for a number of tram engines.

It is evident that, with a properly constructed plant of stationary boilers of first class workmanship—none other would be advisable for such high pressure, and an injudicious attempt to save in this plant might lead to serious difficulties—steam can be produced in the most economical manner; hot feed, large grates, cheap fuel, and a reduced staff of attendants all help to materially reduce the cost of steam. Returning now to the fireless tramway engines, we find that one engine driver is quite sufficient for each locomotive, which results in the saving of a stoker, and although the stationary plant requires stokers, two men can easily attend to two boilers, and since each boiler can supply four locomotives, six men less are employed for every eight engines. Boiler repairs being all but avoided, a smaller number of stand-by locomotives are required, reducing not only the capital involved, but also cost for repairs, and requiring smaller repairing shops.

Great benefits result to the traveling public from the absence of fire in these locomotives; there are no flying sparks, ashes, cinders, and unpleasant products of combustion, the engine and carriages remain longer clean, and costs for cleaning and repairs alike are reduced. There is also a saving in labor and fuel due to the circumstance, that the engines do not require to be lighted up in the morning; they are charged before being brought into the sheds at night, and although they lose from 30 lb. to 60 lb. pressure during night, they are ready for work at any moment's notice.

The working expenses, consisting of wages and materials, amount to 4*d.* per mile for fireless locomotives, and 5·44*d.* per mile for ordinary tram locomotives, or 36 per cent. higher, and although in the latter case the capital involved is about 20 per cent. higher, tramway lines worked by fireless locomotives yield from 40 to 50 per cent. more profit than those worked by ordinary locomotives. Conditions occur frequently, where it is quite impossible to work tramways by ordinary locomotives; for instance, in cases where there is danger of fire from flying sparks or dropping ashes, or where, in consequence of existing circumstances, the weight of the engine required for the traffic would exceed that admissible on the permanent way. The latter case may of course even exclude fireless locomotives, but to explain this point more clearly, it will be best to investigate a few special cases. The two stations, A and B, the latter of which is situated about 330 feet higher than the former, are to be connected by a steam tramway; the line is altogether about 1·83 miles long, of which two-thirds, or 1·25, is on an incline of 5 per cent., the remaining third being level. The permanent way is to be constructed for loads on one pair of wheels not exceeding 2·5 tons, and each train is to consist of three carriages, which, loaded, will weigh 4 tons each, or a total of 12 tons; the engine to be strong enough to maintain the highest speed allowed on tramways in Germany, viz., 9·3 miles an hour throughout the journey.

With the fireless locomotives under consideration, it would become necessary to fill the engine at station A, having high pressure available for the ascent, while for the descent on the return journey, the lower pressure would be ample. These conditions would in reality most frequently exist, since water and fuel are more likely to be easily obtained at the foot than at the top of the incline.

The mean train resistance at a speed of 9·3 miles per hour on a horizontal line is about 22 lb. to 24 lb. per ton, or it may rise with dirty rails to 26 lb. or 30 lb. We will for our calculations take it to be 24 lb. per ton. The additional resistance due to an inclination of 5 per cent. is about 110 lb.; the engine therefore has to be constructed for a total resistance of 134 lb. per ton. If we assume an engine weighing in working order 9½ tons, we have a total weight of train of 21½ tons, the train resistance being equal to 2,880 lb. The proportion of adhesion is about 1: 7·2, which is sufficient. The engine would require a hot water tank of the following dimensions: Let P represent the number of pounds of hot water in the tank, L the distance the train has to run in feet, H the total height in feet to which the train has to rise, and Q the total weight of train in pounds.

Assuming an initial pressure of fifteen atmospheres in the reservoir, and working down to a terminal pressure of about three atmospheres, we have about 4,950 foot-pounds of work for every pound of water. The quantity of water required is therefore

$$P=\frac{\frac{24\times 13.200}{2,240}\times 300}{4,950}\times 21\cdot 5\times 2,240=4,586 \text{ lb. of water,}$$

or nearly 459 gallons.

The hot-water reservoirs of engines weighing 9½ tons have been made to contain 462 gallons of water, which has been found amply sufficient. To construct an ordinary locomotive for the same work would require some 73 horse power, which could not well be obtained in less than 13 tons weight, and this would necessitate heavier permanent way, and would require an extra amount of fuel and water to carry the additional dead weight.

A very important advantage in favor of fireless locomotives is the fact that the power stored in the hot-water reservoir may be used as conditions require, and a uniform speed can be kept up on rising gradients as well as on level, a result not obtainable with ordinary locomotives.

Where the exhaust is used as chimney blast a slow speed causes, moreover, a slower combustion, and it is not a rare occurrence that locomotives come to a dead stop on steep gradients, an accident that cannot happen with fireless locomotives, since they always possess a very large store of power.

On long lines, even if approximately level, the weight of engine is necessarily larger in consequence of the large quantity of water to be carried. For lines where a train of about 20 tons has to be transported a distance of about 12 miles, the locomotives are constructed of 15 tons weight, carrying 1,000 gallons of water.

For short distances and light weights, such as frequently occur on narrow gauge lines, the engines are very light and small. Assuming a distance between two stations of only 1·25 miles (0·37 of which is on an incline of 1: 40), and a train of but 6 tons weight to be taken out and home again; then the total distance traveled with steam is 2·50—0·37=2·13 miles, and an engine of 2·5 tons total weight, carrying about 100 gallons of water, would be found sufficient. Cases of this kind may be met with in sugar and other plantations, in ore and limestone pits or mines; in the latter case fireless locomotives are admirably adapted to run in the workings, where ordinary locomotives could not possibly be employed in consequence of the discharge of combustion gases. Frequently, even the exhaust steam can, in places of this kind, be condensed by being discharged into the drains running along the bottom of the workings.

As we have already shown, this system of fireless locomotives is admirably adapted for steep gradients; in our first case we assumed gradients of 5 per cent., and a locomotive of 9½ tons, working a train of three carriages of 4 tons weight each. The same engine would be able to overcome gradients of 8 per cent., or 1 in 12½ with only one carriage, while ordinary lines as steep as this would be considered problems for rack locomotives.

An excellent field for the application of fireless engines is open in small river steamers which have only to run short distances. In place of a boiler, these steamers carry a water reservoir, and they are charged with steam at the landing pier, through well protected piping. On small steamers, boilers are frequently worked at great disadvantage; they are indifferently attended to, difficult to clean, and frequently worked when in a dangerous condition. It will, moreover, be acknowledged that small marine boilers are difficult to manage; they have but little water space, steam rises and water falls rapidly, and it can only be surprising that explosions do not happen more frequently.

For these reasons stated above, the fireless arrangement appears admirably suited for small steamers. In laying out the stationary boiler plant for supplying the necessary steam, economically constructed boilers with large water contents, steam room, and large steam surface should be provided, evaporating about 3·5 lb. of water per square foot of heating surface per hour. In calculating the dimensions of the stationary plant, it may be assumed that about one-ninth of the contents of the reservoirs has to be resupplied at each charge; if, therefore, the engine we calculated of 9½ tons total weight carries 4,540 lb. of water, it would require 550 lb. of steam at the commencement of each journey. According to the facilities provided for charging the reservoirs, the time required between the arrival of a locomotive and the departure of its train varies between 20 and 30 minutes; if, therefore, a train is to start every 5 minutes, from four to six engines will always be in the boiler house for charging. Adding to a journey of 45 minutes, 25 minutes for charging, we have 70 minutes as the total time employed, and if trains are to run every 5 minutes, 14 locomotives will be required, of which 9 are running while 5 are being charged. Since these engines would probably be worked 5 days out of 6, only 3 more engines would be required, and a reserve of three more would complete a plant of 20 locomotives for a constant service. If this service is carried on with the locomotives we have been several times referring to, of 9½ tons weight, we should require three boilers of 720 square feet of heating surface each to supply 12 engines every hour. The stationary plant should, however, of course, have one standing boiler, and consist of 4 boilers of this size.

This system of fireless engines was first introduced by Dr. Lamm, of New Orleans, in 1872, and the first engines were started on this principle in 1874. Dr. Lamm, however, died soon afterward. M. Lion Francq, of Paris, built an engine on this principle in 1874–75, in which he introduced numerous improvements, and in the following year a series of careful trials were made with these engines. At present M. Lion Francq is manager of the Compagnie Continentale d'Exploitation des Locomotives sans Foyer, in Paris, and this company is working the system of fireless locomotives.

As we have mentioned in an early part of this paper, the Hohenzollern Locomotive Works, at Düsseldorf, are at present building a large number of fireless locomotives and plant for Java, and an interesting series of comparative trials is now being carried out on an experimental line near to these works, between fireless and ordinary locomotives.

The fireless locomotives are being fed from one of the stationary boilers built for Java, and run the whole distance for which they are afterward intended, drawing behind them the proper train weight. These trials afford an excellent opportunity for all interested in light and cheap steam tramway traffic to compare the fireless with the old system.—*Engineering.*

AUTOMATICALLY CLOSING VENTILATING CHAMBER FOR COAL MINES.

COAL mining, especially in Belgium, has reached a considerable amount of development in a relatively short space of time. Everybody long ago foresaw that the time would come when the miner would have to go to the deepest recesses of the coal basins to obtain a product which has become an absolute necessity to the industries. In proportion as the works extend, it is readily understood that the cost of extraction becomes larger and larger, the installations more costly, the works of the first establishment more expensive, and the amount of capital invested greatly increased. For such a situation of the coal mining industry, but a single remedy can be offered, and that is to increase the production per "side of work." The majority of engineers have turned their attention in this direction, most of them in directly improving the engines for extraction, and others in trying to utilize the shafts that are specially designed for ventilation.

It is evidently out of place to discuss the value of the improvements introduced into the machines, and we can only praise such efforts; but we think, however, that the second class of ideas is more natural and logical than the first. In fact, are we not putting ourselves in a way of possibly doubling the production of a side of work by effecting the extraction through the air-shaft? And is it not solving in the simplest and easiest way the problem that every mining engineer has had to propose to himself? But, it will be asked, is not extraction through the air-shaft attended with drawbacks? And will not the rapid ascent and descent of the cages interfere with the ventilation? We answer that such an argument is as true for the upcast shaft as for the downcast, and yet no one has ever recognized the necessity of creating a shaft which shall be exclusively reserved for the entrance of air into a mine. On the contrary, the air-shaft, on being utilized for extraction, will be oftener examined, and consequently the ventilation, far from being interfered with, will have less resistance to overcome.

We may conclude, then, that extraction through the air-shaft is both rational and judicious.

Principle and Description.—In order to put this idea in practice, it is only necessary to find some arrangement which shall put a special inclosure in communication with the air-shaft and with the external atmosphere. The question has been solved in the following way by Mr. Birnaux, at the Monceau-Fontaine Coal Mines, Belgium. (See next page.)

The ventilating chamber is put in communication with the pit by means of the door, *p'*, while a similar door, *p'*, permits likewise of entrance from the outside to the interior of the inclosure. This door closes by its own weight and is entirely independent of the other one. It is maneuvered in the following way:

The cage, on reaching the light, raises the counterpoise, C (Figs. 1 and 2), which rests on a slide, G, connected with the door, *p'*, by means of a chain. At this moment the air chamber is in communication with the external air. But during the passage through the space, L, equal to the length of the door, the latter, becoming free, cedes to its own weight and closes. Then the counterpoise, C, reaching the level of the catch of the door, *p*, lifts it and puts the chamber in direct communication with the air-shaft.

Such is the principle that has served as a basis for the installation of the system under consideration.

Fig. 5 shows a horizontal projection of its essential lines. P P represent the doors of the chamber, and *p p'*, those of the pit.

Let us suppose the cage, C, has reached the surface, and that the door, *p'*, is open, and P closed. But, since *p* has remained closed, it results that P leaves the external air free to enter the interior through the space from P to *p'* (Fig. 5).

It is in order to avoid such an inconvenience that the two doors, P and P', have been placed opposite the opening, O (Figs. 3 and 4).

The working of the apparatus may be resumed, then, as follows:

When the cages are along the shaft, the doors of the pit are completely closed, and those of the chambers are open. When a cage reaches the pit-mouth, the door of the corresponding pit is open and the external door is closed. The problem is solved, then, and the maneuver is as follows:

1. Entrance of the cars into the air chamber on the arrival of the cage at the surface.

2. Exit of the cars during the passage of cages along the shaft.

In order to hasten these maneuvers, the arrangement may be doubled in such a way as to have one chamber for the empty cars, and another for the full ones. This is what has been done.

The same principle might be applied in employing only one external door, as follows: making pulley *m* stationary, and pulley *m'* movable in a vertical direction (Fig. 6). In order to raise the door, *m'* would have to come to *m''*, and *p* would have to be lowered. The first motion would be accomplished by the door, *p*.

Although such an arrangement presents a certain complication that has caused its rejection, we have thought it well to refer to it.

As for constructing materials, the choice lay between wood, masonry, and iron plate. The latter was chosen because of the possibility of effecting with it a tighter closing.

Plate iron, in fact, permits of having joints that are perfectly impermeable to air, and of intercepting completely all communication of the atmosphere with the mine. The other two materials present more or less porosity. With plate iron, the construction of the ventilating chamber is very simple, and here is how it has been done: simple T-irons are arranged as uprights, at a distance apart equal to the width of the air-lock. These irons, which are placed opposite each other, are connected by a third, of the same dimensions, which forms the frame for the roof. The iron plates are nailed to the exterior. The joints might be made by interposing felt or rubber between the plates. As for the uprights, these are solidly connected by bolts, and by an iron beam at the base.

The upper part of the air-lock is arranged in the form of clack-valves. These latter, in case of an explosion of fire-damp, would act as a safety-valve, and, by rising, would prevent the repercussion of the explosion from communicating to the ventilator.

RECENT TELEPHONE EXPERIMENTS IN PARIS.

THERE was a very interesting experiment performed quite recently between the Hippodrome and the offices of the International Telephone Co., 15 Place Vendome (Paris). The orchestra of the Hippodrome, which plays during the day and evening for the two daily performances, was heard distinctly by numerous invited guests assembled at Place Vendome. There were ninety-six telephone receivers, and, each auditor having two of them, forty-eight persons were enabled to hear at the same time. Owing to the fact that one of the two wires that usually serve for the direction of the Hippodrome was in use, only one wire was disposable for the experiment. The apparatus were arranged at the Hippodrome as follows: There were twenty-five microphone transmitters mounted on a single board, which was inclined slightly from the horizontal over the leader of the orchestra. The microphones were, it should be understood, above the board and protected from dust by a light box. The board itself was supported by four cords. The pile consisted at the beginning of three Reynier-Faure accumulators. The intensity of the current was indicated by a Deprez galvanometer placed in the circuit, and was kept sensibly constant by adding to these three accumulators another, then another, until the total number was nine. The current of the pile was branched between the twenty five microphones, then into the twenty-four primary wires of twenty-four induction coils that were mounted by twos in series of twelve on a derived circuit. The intensity of the current was twelve amperes. The twenty-four secondary circuits of the twenty-four induction coils were grouped by fours in series, and six on a derived circuit. The resistance of each was 300 ohms, or altogether 1,200 ohms. The line from the Hippodrome, 3,512 meters in length, ended in one of the offices of the General Society of Telephones, Rue Petits-Champs, where also ended the line from Place Vendome, which was a very short one. The receivers, which were of the Ader type, were grouped by sixteens in series, and six on a derived circuit.

The clearness with which the music was heard was perfect, and all the auditors were perfectly satisfied with the result.

In the arrangements noted above, which were a great improvement over those employed at the Exhibition of Electricity, the principal novelty consisted in the association of the twenty-five microphones on a derived circuit, and in the association of the twenty-four secondary wires of the induction coils for tension and quantity, as is done with pile elements.—*L'Electricien.*

IN Mr. Werdermann's new incandescent lamp the vacuum indispensable in all other such lamps, is dispensed with, and he employs silicum in place of carbon, and it is said he has succeeded in procuring better results than if carbon were employed.

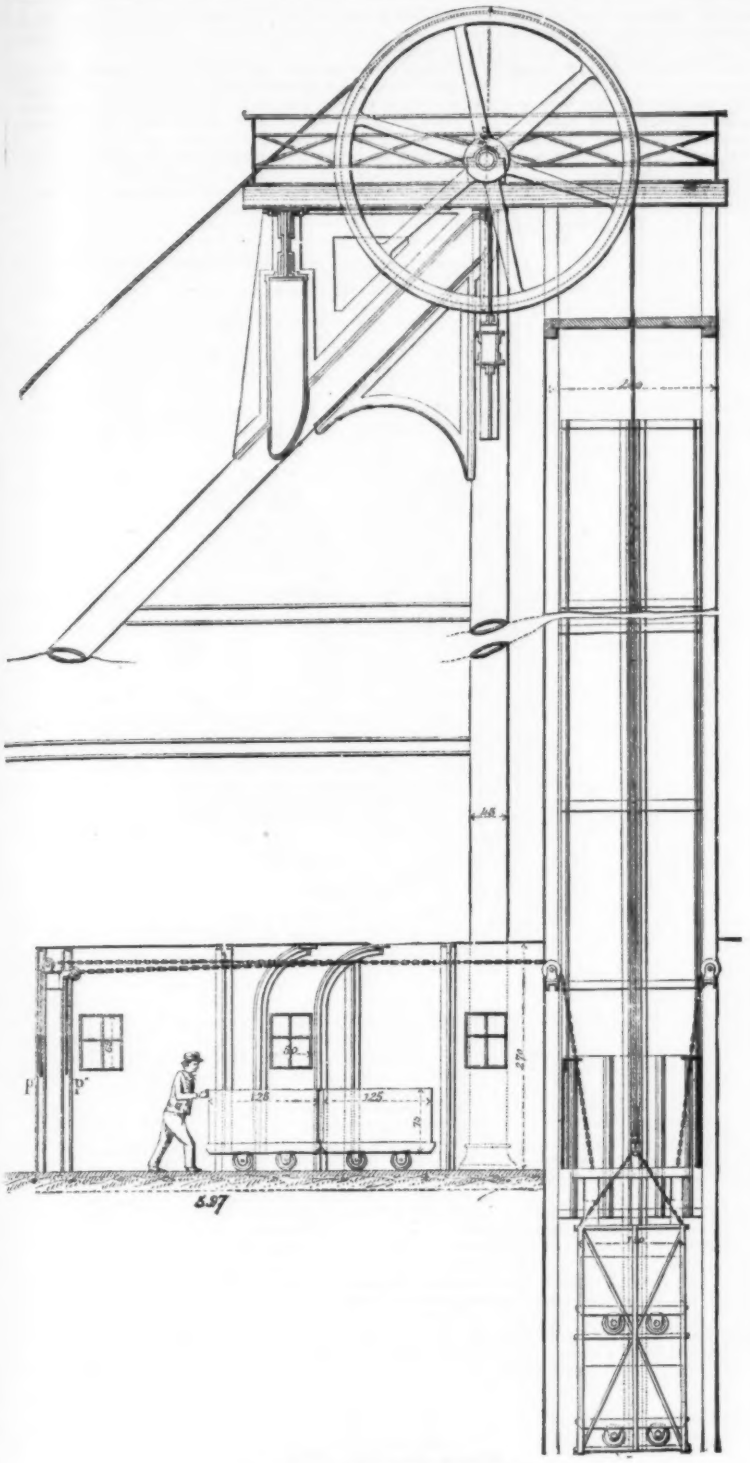


FIG. 1.—LONGITUDINAL SECTION.

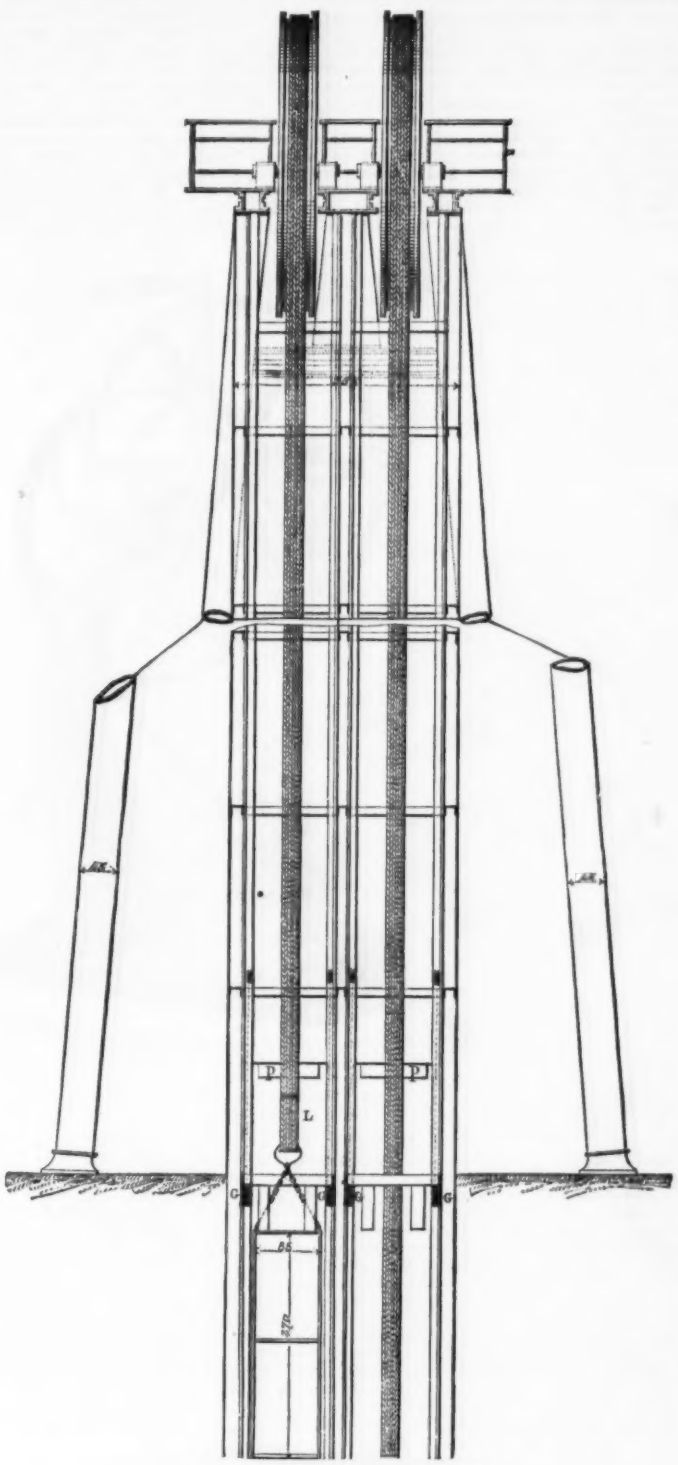


FIG. 2.—TRANSVERSE SECTION.

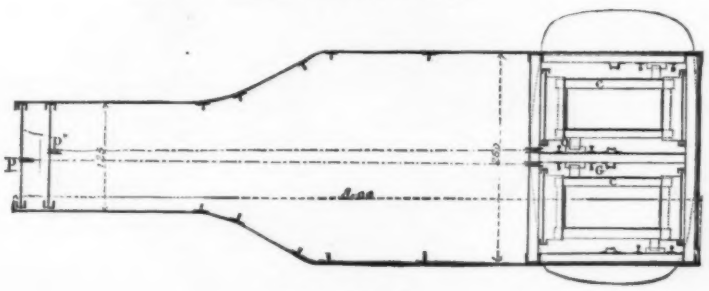


FIG. 3.—PLAN.

Fig. 4.

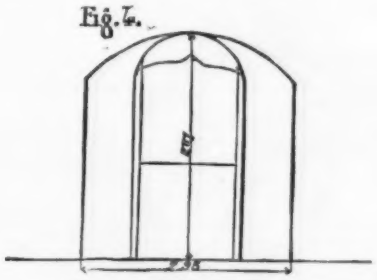


FIG. 4.—FRONT VIEW.

Fig. 5.

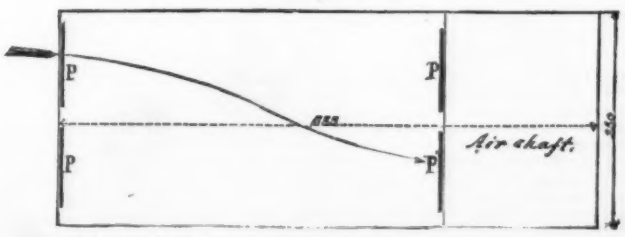


FIG. 5.—PLAN.

Fig. 6.

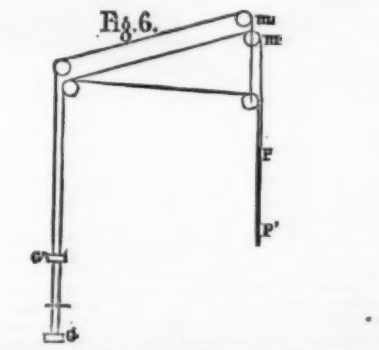


FIG. 6.—ARRANGEMENT FOR SINGLE DOOR

AUTOMATICALLY CLOSING VENTILATING CHAMBER.

DE MERITENS'S NEW MACHINES.

DURING the half score of years that ring machines have been in practical use, they have been the object of a series of successive improvements, and the state of development which they have now reached allows us to assert that the problem of converting mechanical work into electric current is to-day in great measure solved. This first point—a very important one—once attained, dynamo-electric machines still exhibit one quite great defect, and that is their price, which is a little too high for industrial applications.

The cause of this is partially due to the fact that, in the price of the machines, the consumer is still often paying for the patent rights, and partially to the fact that when the manufacturing was begun little attention was paid to cheapness. The custom once established, catalogues once got up, things have remained nearly *in statu quo*. But now that the patents on the principal machines are on the verge of becoming public property, and that, moreover, an extensive examination of the Pacinotti machine has shown that some of these are void, the aim of manufacturers ought to be to put their apparatus at the most moderate price possible, so as to make their use general. Several makers have taken such a step, and among these we may mention now more particularly Mr. De Meritens, who has turned all his efforts in this direction toward the Pacinotti machine. Our collaborator, Frank Geraldy, has already described in our number for Dec. 28, 1880, the industrial form that he has given the Italian machine, while at the same time preserving the mode of construction of its ring.

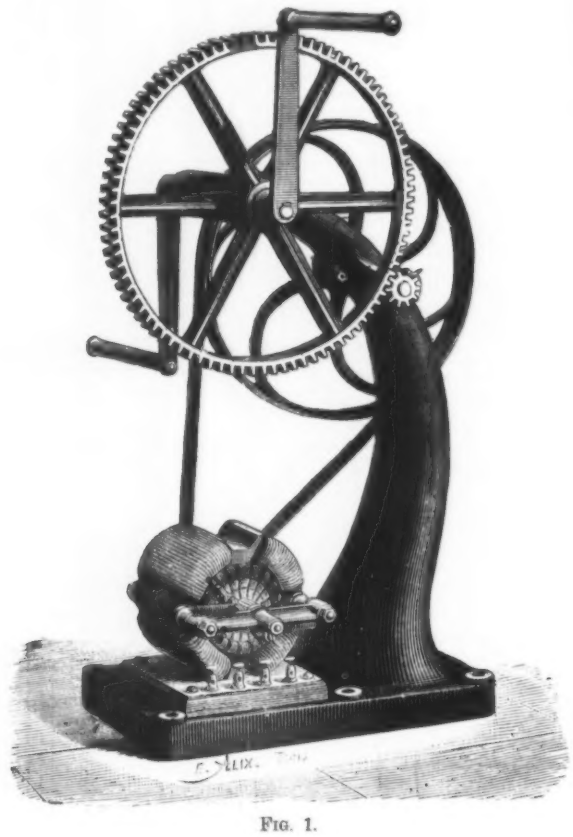


FIG. 1.

Since that epoch Mr. De Meritens has first endeavored to render the use of his first type (which he designates by the letter C) possible in public courses of lectures.

For that purpose he has added to this model a system of gearings serving to work it by hand. Fig. 1 represents the machine provided with such an apparatus—a large toothed wheel furnished with two winches, by means of which four men may set the machine in operation at a proper speed. If, under normal circumstances, the work that one man can effect is only six kilogrammes per second, he may in an effort of some instants reach a much higher figure. That is why four men acting on the two winches can, during a few minutes, effect sufficient work to keep up on the machine an electric regulator of a hundred Carcel burners. The light, as may be seen, can be maintained only for a very short time, but such time is amply sufficient for an experiment in demonstration. The professors for whose benefit this machine has been got up will certainly appreciate an arrangement that makes it possible for them to operate before their pupils the principal electric lamps without the necessity of setting up a motive power or of mounting fifty pile elements.

Without in any way changing the construction of the original machine, Mr. De Meritens afterward devised a second type, designated by the letter I. This differs from the original apparatus only in being longer, and of larger dimensions. It revolves nominally 2,800 times per minute, and is capable of supplying in tension two foci of sixty Carcel burners (Fig. 2).

The cylindrical form given the electro-magnet inductors complicated the construction of the machine somewhat, and Mr. De Meritens has therefore thought that it might be simplified by using flat inductors, so as to give the machine the form of a right prism with rhombic base. As the polar expansions naturally fit in two of the angles of the space in which the bobbin is situated there is no very preceptible loss of room. This idea has given rise to two types of machines, which are shown in Figs. 1 and 3. The first of these, designated by the letter J, is a machine of relatively small size designed to supply a focus of 180 Carcel burners. Its number of revolutions, like that of type I, is 2,800, and it absorbs a power of 2½ horses. The second machine, or type H, is capable of supplying a focus of 650 Carcel burners at an expenditure of a power of 4 horses, in revolving at a normal speed of 1,600 turns per minute. A machine of this kind will be applicable for supplying large foci such as those employed for lighthouses. The same machine is capable of supplying 25 Swan incandescent lamps of 2 amperes, and its electro-motive force is 80 volts. As regards weight, that is reduced as much as possible in these machines. The first type, C, has been somewhat lightened, and in its present state weighs only 30 kilogrammes. Type H, which is the most powerful, is 224 kilogrammes in weight, and model I weighs only 47 kilogrammes. These are, as may be seen, very moderate weights relatively to the power of the machines.

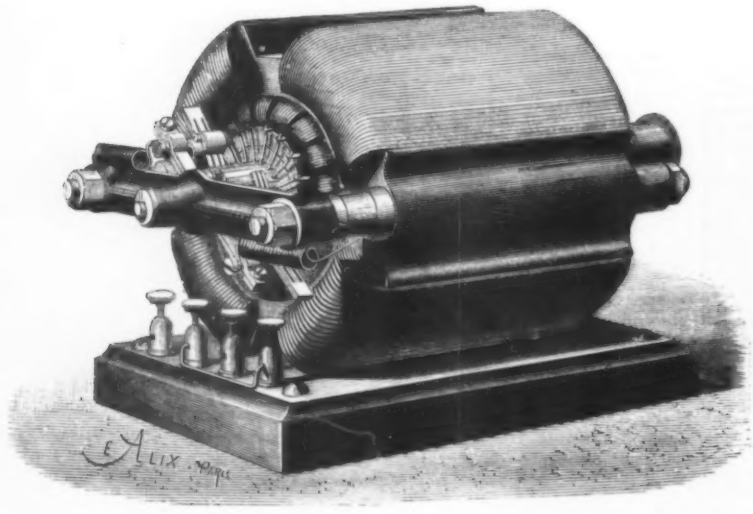


FIG. 2.

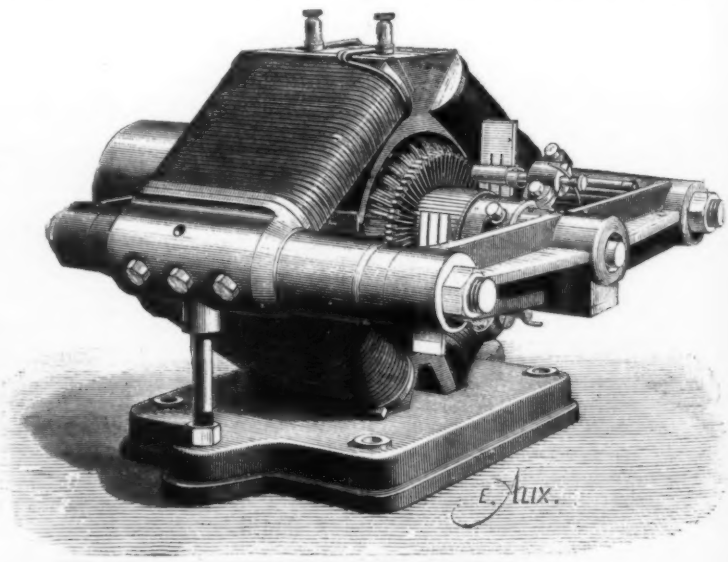


FIG. 3.

Following the method pointed out by Deprez, Mr. De Meritens has studied these different machines by causing the external resistances to progressively vary. The accompanying table gives the results that he obtained for type C, whose inductor and revolving armature had each a resistance of 1·33 ohms. It should be remarked that the resistances indicated in this table are external ones, and that, to have the total resistance, there must be added to them the resistance of the machine, equal to 2·66 ohms:

Intensity in Amperes.	Electro-motive Force in Volts.	Resistance in Ohms.	Intensity in Amperes.	Electro-motive Force in Volts.	Resistance in Ohms.
10·69	55·05	3·49	4·50	53·95	9·33
9·66	65·11	4·08	4·14	52·04	9·91
8·97	65·66	4·66	3·96	52·07	10·49
8·28	65 41	5 24	3·70	50 08	11·08
7·59	64·44	5·83	3·45	48·40	11·66
6·90	62 58	6 41	3·17	47·26	12·25
6·55	63·21	6 99	3·11	48 17	12 88
5·86	60·00	7·58	3·10	49 82	13·41
5·35	57 88	8·16	2 80	46·62	13 99
5·00	57·00	8·74	....	....	...

Intensity in Amperes.	Electro-motive Force in Volts.	Resistance in Ohms.	Intensity in Amperes.	Electro-motive Force in Volts.	Resistance in Ohms.
1·00	15·98	15·16	15·72	57·85	2·91
1 20	17·72	14 00	20 29	62 90	2·33
1·41	19·18	12·83	22 50	63·28	2 04
1·78	21·50	11·66	26·38	66·48	1·75
2·12	23·87	10·49	27·69	65·35	1 59
3·00	30·30	9·33	29·23	64·89	1·45
4·00	35 72	8·16	31 80	65·83	1·30
5·66	43·98	7·00	35·10	67·74	1·16
7·35	48·51	5·83	37·51	67·14	1·02
9·54	51·80	4·66	51·45	69 46	0·58
13·19	56·19	3·49	.....	.....	....

The second table gives the result of analogous experiments made with the machine H, whose resistance is 0·76. On drawing up the characteristics of these machines, by aid of the figures contained in these tables, we obtain curves that indicate good structural conditions.

We may add that in types I and H the prismatic form presents great facilities for construction. The shell of the machine may, in fact, be cast all entire in two parts, and the winding of the wire may be performed very easily on each of them. It is only necessary to afterward bring them together in order to form the frame of the apparatus, to which there is nothing more to be done but the fitting to it of the induced ring.

Before ending this article we shall point out still another improvement introduced by Mr. De Meritens, not in dynamo-electric machines, but in carbons for lighting. For powerful foci, like the lamps in lighthouses, there are used, especially in the lighthouses of large size in England, carbons of very large diameter. Now it is very difficult to procure large carbons that shall be homogeneous, and, on the other hand, in the majority of cases their baking has not been evenly performed. The external parts are naturally baked harder, and are drier than the central. These two circumstances interfere with the regular combustion of the carbons, and prevent steadiness in the light as a consequence thereof. In order to remedy this trouble it has occurred to Mr. De Meritens to substitute for the large carbons a bundle of small rods of the same material, each having a diameter of three to four millimeters. These rods are connected together by a few copper wire binders, and their number is proportioned to the size of the bundle to be obtained. Each of them is invested with copper, as is also the bundle itself. In this way the rods hold together well and form a whole which may be considered as very homogeneous by reason of the very thin layer of copper deposited on them by the pile. These compound carbons give a very regular light, and it is observed that, even aside from regularity, the light obtained is more intense than with rods of a single piece.

It will be understood, moreover, that this should be so, since all the parts of the bundle being baked to an equal

degree there occurs in the central parts no longer any disturbing action.

Bundles of this kind, four centimeters in diameter, have been tried in the large apparatus of English lighthouses, and have given results that were in every respect satisfactory, so that they are going to be hereafter substituted for the old style of carbons.—*A. Guerot, in La Lumière Electrique.*

SABINE'S ELECTRIC APPARATUS.

WE figure herewith two electric apparatus invented by Mr. Sabine. The first of these (Fig. 1) is quite a simple galvanometer designed to facilitate reading in electric measurements. This apparatus, which is astatic, is, in its general arrangement, of ordinary construction; but the bobbin is included between two vertical screens, one of which carries a graduated scale, while the other contains an aperture carrying a lens. The upper needle carries a long index whose vertically raised point moves in front of the scale, and if it be looked at through the lens the deviations can be read very clearly. These deviations are thus amplified by a very simple means that does not require the use of a lamp and a system of reflection.

The second apparatus (Fig. 2) is designed for the discharge of condensers or analogous instruments in case it is desired to obtain a more or less long duration of discharge for study. The principal part is a disk, D, which tends to revolve with a certain velocity under the influence of a spring placed in the interior. The disk begins its travel at the moment the lever-handle, M, is depressed, and then establishes a contact with the charging pile. The charge lasts but an instant, and the apparatus experimented with is afterward insulated. Then a discharge occurs during a period that may be made to vary by means of the apparatus. For this purpose the position of the alidade, C, is regulated on the disk, D, in such a way that it makes an angle with the zero of graduation of the disk, representing the number of seconds during which the discharge must be effected. The condenser, then, is in metallic contact with the disk during a time which is so much the longer in proportion as the arc separating the alidade from zero is greater, and the duration of the discharge is proportional to the length of the arc. Once this latter having been traversed, the condenser becomes again automatically insulated. So the discharge has lasted exactly the time that had been assigned to it beforehand, at the moment the apparatus was regulated.

It is easy to see what a great convenience such an arrangement presents for the study of the discharge from condensers, when it is desired to study the influence of time upon such discharge, after a charge lasting but an instant. It will also be readily understood that by modifying the communications of the apparatus, it may be made to serve for other researches than those that we have just pointed out, and that it is capable of rendering quite extensive services.—*La Lumière Electrique.*

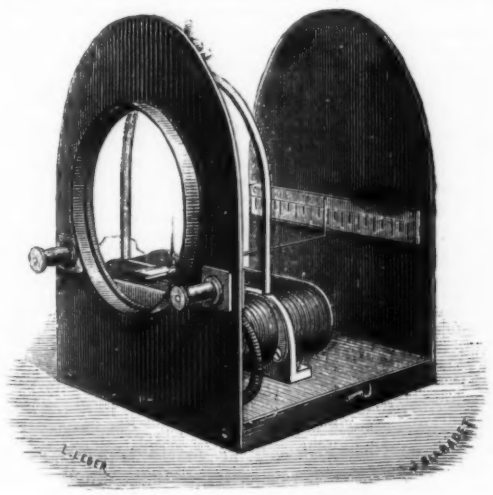


FIG. 1.

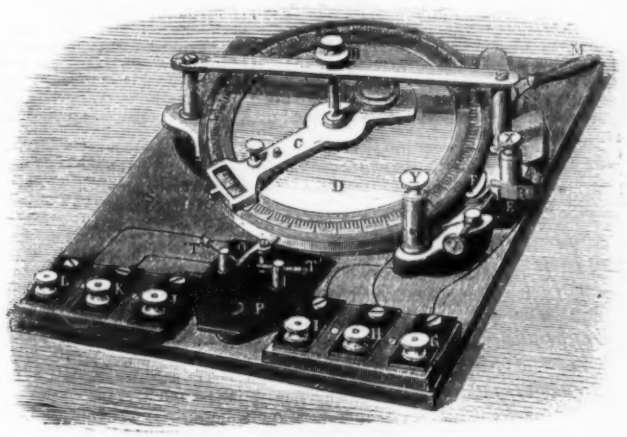


FIG. 2.

HUNTING BY THE ELECTRIC LIGHT.

THERE is a mode of hunting which is of almost savage simplicity, and which has been employed from time immemorial; it is called "fire-hunting." The accessories consist of a sort of metallic pan having for handle a long pole affixed to a piece of board. This apparatus is supported on the shoulder, while a mixture of resin and pine-cones lighted in the pan produces a bright light. The north of Canada, where this style of hunting is practiced, is covered with snow during the greater part of the year, so it may be imagined what dazzling effect such a light must produce on a dark night. The animals that are met with—both deer and carnivora—are frightened by it, and do not dare to stir a step. The experienced hunter soon perceives them and can judge of their distance by the width of space between their shining eyes. Having made this calculation he rests his rifle on the board above mentioned, takes aim, and fires.

Fire-hunting is not only practiced in America but also in Southern Africa and in the English Indies. A large English landowner in Lancashire, England, having become enthusiastic over the accounts of the hecatombs of large game and ferocious animals that are made in this way, decided a couple of years ago to try the method in his own country on birds. But the system employed by trappers being too primitive to suit his fancy, and thinking that in a civilized country recourse ought to be had to the latest improvements, he selected electricity as a source of light for his purposes. A portable engine and a Gramme machine were therefore taken to the spot chosen (an immense heath surrounded by brush), and here, in a very open place, there was erected a frame consisting of four poles united at the top by cross-pieces. From this frame there was suspended a powerful electric light. The accompanying engraving represents the moment of the horrible massacre. A very dark night was chosen, and numerous persons were sent in all directions to awaken the game and drive it towards the light. The hunters invited to the killing were on hand well provided with ammunition. The birds awakened in the depths of night, at first flew at random, but as soon as they perceived the great glare of the electric light, turned toward it and went flying round and round the frame, which had been covered with a sort of grating. Then the firing began, and was kept up till the greater part of the game was killed. When the shameful destruction was finished, and the victims were counted, 464 grouse, 11 snipe, 148 partridges, 5 sparrow hawks, 2 owls, and an enormous number of birds of all species were found lying bleeding on the ground, a witness to the barbarity of men who, under the pretext of eccentricity, had committed the act.

HUNTING BY THE ELECTRIC LIGHT.

The reprobation for the deed was universal in England at the time, and if we publish to-day an account of this electro-cynegetic crime, it is certainly not to encourage its repetition, but only, as faithful historians, to recall one of the strangest applications of the electric light, and to associate ourselves with all the civilized disciples of Saint Hubert.—*La Lumière Electrique.*

HOW CLAY PIPES ARE MADE.

NOTWITHSTANDING the great increase within a few years past in the consumption of cheap cigars, the enormous demand for millions of made cigarettes annually—a trade that hardly existed ten years ago—the widely spread custom among smokers of making their own cigarettes, and the large importation of cheap and durable wooden pipes, the business of making clay pipes has never been more flourishing than it now is. Of important clay pipe factories, there are three in Brooklyn, two in Baltimore, three in Detroit, two in Woodbridge, N. J., and one each in New York City, Union Hill, Newark, Providence, Cleveland, Syracuse, and Rouse's Point. In addition to these there are thirty or forty small concerns scattered about the country that manufacture only to supply local demand, and give employment to from one to four men only in each. Canada also maintains three considerable factories—one in Quebec and two in Montreal. These are all engaged in turning out cheap clay pipes of the sort usually retailed at one cent. But a few years ago two-thirds of the common clay pipes smoked in this country were imported from Scotland and England; but now hardly one-sixteenth of the demand is supplied from that source, and it is this change in popular preference, as well as an increase of the number of smokers using these articles, due, doubtless, in a measure, to the great number of immigrants constantly arriving, that makes this particular branch of manufacture so especially lively just now.

It seems to the looker-on an excessively simple thing to make clay pipes, a work that any smart, intelligent boy ought to learn in two hours, yet, singularly enough, this is one of the few trades in which long apprenticeships are still the rule rigidly enforced. The regular term of apprenticeship in this country is three years, and in Great Britain five years, even now. Many workmen now employed here have served as many as seven years' apprenticeship in England. A skilled pipe moulder earns from $8 to $16 a week, according to his industry and quickness. The clay of which most of the pipes in this country are made is obtained from pits either in Woodbridge, N. J., or in Maryland, near Baltimore. The Detroit and Canadian factories get theirs from Liverpool, water transportation making it cheaper to them than the American product.

All these facts about the trade, and many more, a reporter of the New York *Sun* gleaned the other day from the Superintendent and two or three intelligent-looking Scotch and English pipe moulders in the principal factory of Woodbridge, N. J., while they went on with their work.

The white clay is worth $3.50 per ton, and the rarer red clay, which is dug out at Bonhamtown, near New Brunswick, N. J., is worth $5.50 per ton. In the pits near Woodbridge it is obtained from a depth of fifty or sixty feet. It is not in regular veins, but in pockets, or lumps, here and there, amid inferior clay that must be carefully kept from admixture with it. The clay that is blue when it comes out of the ground—speaking now of that which is fine enough and otherwise suitable for pipe making—turns white when burned, excepting one English variety, which becomes red; the white clay turns yellow under the action of the fire, and the red clay retains its color.

The English clay not only has, when in a finished pipe, a finer natural gloss than the American, but it is tougher; and, whereas the American will not stand moulding well into a stem more than seven inches long, it is not at all uncommon to make stems as much as thirty inches long from the English clay. For smoking, however, the English pipe is not so good as the American, being less porous. The most porous and consequently the best American clay pipe, and consequently the best clay pipe in the world, is the Powhatan, which is made only from clay obtained in Powhatan County, Virginia. A close imitation of it comes from near Baltimore, but is not, in the judgment of experts, up to the standard. Now, as to the making of the pipes.

The clay, with such addition of water as may be necessary to temper it properly, is first ground very thoroughly in a mill. Then the roller, placing a great mass of it beside him on a bench, moulds it into tips. He works with both hands, nipping off with each a chunk of just the size that experience has taught him will be enough for one pipe, and deftly pinches and rolls the two pieces simultaneously, so that each, in a second's time, assumes the form of a rough blob, with a long tail to it. A dozen of these he sticks together lightly

in one lump, and in this form they lie for several hours, until the clay has attained, by partial drying, the proper hardness for successful moulding. Then they pass to the moulder.

Each moulder sits at a low bench, with the simplest possible form of a lever press before him, merely an arm from which an iron "stopper" depends. He also has an iron mould, in two parts, hinged together. The interior of this mould is covered with whatever emblems or letters it is intended that the pipe shall bear in relief upon its surface. Taking up a tip of clay and touching it lightly with oil to prevent its sticking, he lays it in one half of the mould and runs through it a long steel needle, which makes the stem. Then he closes the mould, pushes it into the little press, and brings down upon it the "stopper" that forms the bowl of the pipe. As he pulls the mould out again a sharp swinging knife automatically pares off smoothly the excess of clay squeezed out at the top of the bowl.

All this is done very rapidly. The roller can turn out 384 tips in an hour, and the moulder, who makes $16 a week, must, if he works ten hours a day for six days, mould 256 pipes an hour, or a little over 4¼ a minute, for his wages are only twenty cents a gross. It must be understood that the moulder's dozen is 16, not 12, and his gross 192 instead of 144. That is the liberal allowance made for breakage, loss in baking, and other reductions from the full tale of finished pipes.

After standing on trays in freely circulating air ten or twelve hours, to give them still more hardness, the pipes next pass to the trimmers, girls who take off the mould seam and polish the stem of each pipe with a bit of wood, for which they get five cents a gross, and at this price make from one-third to one-half as much as the moulders. Another period of waiting must now pass, varying in duration from one to four days, according to the weather, and when the pipes are finally dry enough for baking they are filled into seggars—great rough stone crocks—and so stacked up, 300 gross or more at a time, in a kiln, where they are gradually raised to a white heat and kept at it until their baking is completed, say in about twelve hours. There is then nothing more to be done with them, after they cool sufficiently to be handled, excepting to pack them in boxes and send them to market, if they are the ordinary "T D" pipes, or any variation upon that pattern. Unless, perhaps, it may be deemed desirable to give them an extra fancy touch by dipping the ends of their stems in a mixture of saffron tea and milk to make them smooth and color them temporarily a pretty yellow just where the smoker's lips will touch the stem—provided he does not begin by breaking that yellow part off, as most clay pipe smokers do.

Sometimes clay pipes are intended to color like meerschaums. To achieve that they are soft baked, and then covered with a coating of white shellac varnish, which colors brown when the pipe is smoked. There are infinite varieties of clay pipe designs, and the success of manufacturers, particularly in this country, depends in a great degree upon their taste and originality in bringing out new patterns. One factory in Glasgow, Scotland, which is reputed the largest in the world, is credited with having brought out no less than 600 different designs; and another, in Baltimore, Md., is said to have 130 separate styles. The fancy styles are produced at a little more cost in wages to the manufacturer than the plain "T D" pipes, which are the acme of cheapness and plainness. The manufacturer sells a 3-gross box of completed pipes at from $1 to $1.20. His gross does not consist of 192, as the moulder's does, but of the orthodox 144. Of course, a great deal of breakage must be expected among such fragile articles, but there can never be so much that a very liberal profit is not left to the retailer.

THE WORLD'S PRODUCTION OF PRECIOUS METALS.—THE WORK OF THE MINT.

THE report of the Director of the Mint for the year ended June 30, 1882, gives the total gold coinage for the year as 11,266,003 pieces of the value of $89,413,447.50, being nearly $11,000,000 more than on any previous year. About one-half of the coinage was in eagles, one-third in half-eagles, and the remainder in double-eagles. The silver coinage consisted of $27,772,075 in silver dollars and $11,313.75 in fractional coin, a total of $27,783,388.75.

Of the minor or base-metal coins 46,865,725 pieces, of the value of $644,757.75, were struck. The demand for five-cent nickel pieces was large, and 4,400,775 pieces, of a value of $220,038.75, were struck during the year. The remainder of the minor coinage consisted principally of one-cent pieces.

Gold bars of the value of $37,505,120.04 were manufactured, $12,147,674.90 of which were of fine gold for depositors at the New York Assay Office. Fine silver bars of the value of $7,769,898.15 were also made, chiefly at the same institution.

The production of gold for the fiscal year is estimated at $31,500,000, and of silver $44,700,000, a decline of $5,000,000 in gold and an increase of $2,600,000 in silver upon the estimated production for the previous fiscal year.

The consumption of the precious metals in the United States for use in the arts during the year is estimated at $12,000,000 of gold and $7,000,000 of silver, of which $7,000,000 of gold and $6,000,000 of silver were of domestic production. There was issued from the New York Assay Office for the use of manufacturers $1,500,000 more of gold, and $800,000 more of silver bars than in the preceding year.

The total coin of the country is estimated to have been at the beginning of the year, $439,776,753 gold, and $171,459,766 silver, a total of $611,236,519, and at the close of the year $500,776,753 gold, and $199,459,766 silver, total $700,236,519, a gain of $61,000,000 in gold coin, and $28,000,000 in silver. The gains from coinage, less recoinage, were $88,814,091 in gold, and $27,651,816 in silver, and by the imports of United States silver coin $517,778, but the export of United States gold coin was $25,008,659 greater than its import, and including $2,700,000 used in the arts, reduced the gain in gold coinage to about $61,000,000. Of the total metallic circulation $148,000,000 belonged to the Treasury, $112,000,000 to the National Banks, and $141,000,000 was in general circulation.

In twenty of the chief mining countries of the world the production was, of gold $107,773,157, and of silver, $97,659,400, which was an increase of $1,500,000 of gold and $3,000,000 of silver over the production of 1880. The coinage executed at the mints of the fifteen principal countries of the world during the year 1881 was, of gold $136,387,383, and of silver, $100,705,824, a total of $237,093,207, an increase of about $5,000,000 over the coinage of 1880.

The circulation of thirty-four countries, embracing nearly all of the civilized portion of the earth, is given as, paper $3,825,220,078, gold $3,353,673,748, and silver $2,620,769,835, a total specie circulation of $5,974,443,583, and of paper and specie $9,799,663,661.

CORUNDUM—ITS VARIETIES AND USES.

OF this important and interesting mineral there are three sub-species: telesia, adamantine spar, and emery.

Telesia exhibits a great variety of colors. It is pearl gray, bluish white, lavender blue, sky blue, azure or indigo blue, and then is the sapphire of jewelers; or it is peach, crimson, cochineal, and very rarely carmine red, and is then called oriental ruby; hence it passes into violet colored, forming the oriental amethyst; when yellow or reddish yellow it is denominated oriental topaz; when yellowish green, oriental chrysolite; and when of a deep, somewhat brownish green, it is named oriental emerald. The colors are, for the most part, uniformly distributed, but sometimes two or more occur in the same specimen.

It occurs in small, rounded pieces or crystallized in a slightly acute rhomboid or double tribedral pyramid (its primitive figure), of which the obtuse angles measure 94° and the acute ones 86°.

1. Sometimes the acute solid angles, or the summits of the pyramids, are replaced by planes perpendicular to the axis, situated either above or below, or exactly corresponding with the short diagonal.

2. Sometimes the edges of the base of the primitive rhomboid are each of them replaced by a plane parallel to the axis, thus separating the two pyramids by a hexahedral prism with rhombic planes; when the prism is long the terminal pyramids often entirely disappear.

3. Sometimes the flat angles of the primitive pyramids that rest on the common base are replaced by two new planes, thus rendering the pyramids enneahedral as long as any of the primitive faces remain, but when these are obliterated forming a dodecahedron, composed of two hexahedral pyramids united base to base. This modification is often combined with No. 1, in consequence of which the summits of the dodecahedron are more or less truncated.

4. The acute angles composing the solid angle at the summit of the primitive rhomboid are sometimes replaced by secondary planes so inclined to the axis as to form a very obtuse secondary rhomboid.

The variety in the form of a hexahedral prism (No. 2) appears sometimes to contain within it a similar prism, but of a different color. The crystals are small and very small, rarely middle sized. It is commonly more or less transparent, passing into translucent. The luster of the transparent kinds is shining and vitreous; of the translucent kinds generally glistening. When those crystals, in which the summits of the primitive rhomb are replaced by secondary planes, are translucent, the planes just mentioned present that varying luster which is called *chatoyant;* and if these crystals are cut *en cabochon*, or in the form of an ellipse, taking care that the summit of the ellipse shall be situated exactly under the point corresponding with the summit of the rhomboid, there will then be produced the appearance of a star with six rays. Such stones are highly valued by jewelers, and are called star-stones.

The fracture of the blue varieties of telesia is conchoidal, passing into foliated; that of the other varieties is foliated. The fragments are indeterminately angular. Its hardness is only inferior to that of the diamond, and the blue varieties are uniformly somewhat harder than the others. It gives fire with steel, but not very easily. By collision it becomes luminous like quartz, and the light from the red varieties is a very deep fire color, or cherry red. Its mean specific gravity is about 4, but it varies from 3·907 to 4·161.

It is infusible *per se* before the blow-pipe, but when finely pulverized is soluble in borax, and partially in potash. Its extreme hardness, and the powerful affinity that exists between alumina and silex, render it difficult to analyze. According to Bergmann, sapphire is composed of 35 silex, 58 alumina, 5 lime, and 2 oxide of iron. An improved analysis of the same gem was made by Klaproth (by means of caustic potash), with the following results: Alumina 98·5, lime 0·5, oxide of iron 1. Finally, Mr. Chenevix succeeded, by the help of borax, in decomposing this stubborn mineral, and his analysis of the sapphire and ruby may, perhaps, be looked upon as the most correct of any. In the sapphire he found, silex 5·25, alumina 92, iron 1; and in the ruby, silex 7, alumina 90, and iron 1·2. There was a loss of 1·75 in the former and 1·8 in the latter in the process of decomposition.

Telesia occurs in veins in granite and syenite. It is found in the kingdom of Pegu and the island of Ceylon in the East Indies. It seems to have been found by Count Bournon, in the province of Forez, in France, and has been met with elsewhere in that country. It is said, also, to have been discovered in Portugal and Bohemia, and in the north of Italy by Professor Pini.

All the varieties of telesia are valuable in jewelry, but rubies, if not very small, bear a considerably higher price in proportion to their weight than sapphires or any of the other varieties. It is said that the light violet-colored pieces may be rendered colorless by being heated in a charcoal crucible, without impairing any other of their properties, and that such pieces are often sold for diamonds.

The color of adamantine spar is grayish or greenish white, or yellowish green, or sapphire blue, or purplish red, or reddish brown. It occurs massive, disseminated and crystallized in the same figures as telesia. The crystals are middle sized and large. Externally they are for the most part dull and rough, internally they are translucent, semi-translucent, and sometimes, though very rarely, transparent. Their surface is often covered by strongly-adhering spangles of mica and grains of magnetic iron ore, which last is sometimes found disposed through the interior of the crystals. Its internal luster is shining or glistening, between vitreous and resinous. The terminal faces of some of the crystals are chatoyant like telesia. Its longitudinal fracture is straight foliated; its cross fracture is small and imperfectly conchoidal. Its fragments are rhomboidal. Its hardness is considerably superior to that of quartz, and the blue and red varieties are the hardest. It gives fire with steel, but not very easily. It becomes luminous by friction in the same manner as telesia. Its mean specific gravity is 3·981, varying on the one hand as far as 3·875, and on the other to 3·981.

Adamantine spar, in its chemical properties, agrees with telesia. The component parts of that from Bengal are, according to Klaproth: silex 5·5, alumina 89·5, iron 1·25; loss in decomposition, 3·75. The analyses of specimens from the Carnatic, Malabar, China, and Ava, by this and other chemists, differ slightly from the above.

It occurs in veins in granite and syenite and other primitive mountains in India, China, and Ava. From its extreme hardness, it is in great request in the East for polishing steel, and for cutting and polishing gems. The European lapidaries, however, prefer diamond powder on account of the greater rapidity with which it works.

The color of emery is intermediate between greenish black and bluish gray. It occurs massive and disseminated; when in a mass it is generally incrusted with magnetic iron ore, pyrites, and mica; the latter substance generally penetrates the whole mass, giving it, when broken, a silvery appearance. It possesses a glistening or glimmering luster. Its fracture is fine grained, uneven, passing into even splintery. It is about equal in hardness to adamantine spar, cutting flint and rock crystal with great ease. It is heavy, and not easily frangible. When most free from iron it consists, according to Tennant, of about: silex 3·4, alumina 92, iron 4·6.

Emery is chiefly procured from the islands of the Archipelago, especially from Naxos. It is also found at Ochsenkopf, in Saxony, in beds of talc and steatite, accompanied by calcareous spar and blende. It is used largely for cutting and polishing by lapidaries and workers in glass, steel, etc. The emery is stamped to powder and sorted into fineneses by bolting through sieves of different degrees of fineness. For delicate purposes it is sorted by elutriation. It is made up into various forms with gums, resin, glue, clay, etc., according to purpose.

The substance called by Count Bournon compact corundum, and which accompanies adamantine spar, is probably an intermediate variety between emery and adamantine spar. Its color is a deep, purplish red, it is opaque, has a compact splintery fracture resembling a coarse jasper. It gives sparks when struck against a piece of steel, and exhibits a fiery red light by collision. It is extremely hard; specific gravity, 3·9. It generally contains, dispersed through its substance, particles of magnetic iron ore.—*Pottery and Glass Reporter.*

ON COAL TAR.*

By S. A. SADLER, Middlesbrough.

AT the request of your excellent President, I have undertaken to tell you something of what I know of coal tar,† that complex body which in the early days of gas making, and until within the last ten or twelve years, was as difficult to dispose of as it was objectionable to the touch and smell. It is not easy to conceive a more inconvenient product without an outlet; and when, as was the case, it was ever accumulating, with no single virtue, whether of quality, character, odor, or appearance, to gratify thought, fancy, or sense, it may truly and literally be said to have been the *bête noire* of gas makers. Fortunately an extraordinary change has taken place in its value. Some one found that by boiling tar in a closed vessel, and collecting the condensed vapors at different stages, spirituous, oily, and greasy products were obtained, and the undistilled residue in the vessel was found to be a solid black body, having the appearance of the original tar without its offensive stickiness and odor. This was the advent of a new industry, which developed with some rapidity until these simple products, which were used for burning in lamps, lubricating purposes, and asphalting, became as much a drug in the market as the tar itself was previously.

I spoke of tar as a complex body. In its original condition it had baffled the researches of many; but the early tar distiller, eager to make a market, and spurred on by competition, elaborated his processes and multiplied the fractionings. Purer products resulted, and the attention of chemists was excited. Mr. Mansfield, a clever young chemist, with Professor Hofmann, discovered that the spirituous product, or naphtha as it was and is still called, was made up of several bodies, each possessing marked and distinguishing characteristics, with fixed specific gravities and constant boiling points, together with the remarkable property of combining with acids and of forming salts. It is impossible to estimate the value of this young chemist's discovery, being, as it has been since proved, the talisman which has opened the way to a world of discovery and enterprise. I regret that, while engaged in perfecting his discovery, an explosion in his laboratory cut short the career of one of the most promising of English chemists.

Mansfield's discovery in 1849 of benzole in tar—a product which was first isolated by Faraday twenty years previously from benzoate of lime, and which had caused some curiosity from its properties, which are briefly these: composition, C_6H_6; a colorless, mobile liquid, with a smell much like a fresh-cut white turnip; boils at 89° C.; solidifies to a mass of crystals at low temperature; specific gravity 880 at ordinary temperatures; is a powerful solvent of fats and resins; very inflammable; but little affected by oxidizing agents, though readily and violently acted on by nitric acid—may be said to have been the starting-point of a long course of investigations and discoveries with tar. Here is a sample of nitro-benzole, the most important of the aromatic class, and commonly called "essence of mirbane." It has a fragrant perfume, and forms the first step toward utilizing benzole.

Toluol (C_7H_8) was next separated and examined. It is a hydro-carbon much like benzole in appearance, odor, and specific gravity, though more refractive and mobile; but having a different and fixed boiling point of 110° C. It does not solidify with cold, and is highly inflammable; it is decomposed by heat into benzole, naphthaline, anthracene, etc.; nitric acid acts violently on it, forming nitro compounds; and oxidizing agents convert it into benzoic acid. Toluol possesses (like turpentine) the singular property of rendering oxygen active; and when added to a solution of indigo, decolorizes it. Strong sulphuric acid dissolves toluol, while it has little or no action on benzole.

Xylol (C_8H_{10}) came next, although it was previously known as a constituent of wood tar. It boils at 140° C.; remains liquid with cold; has the curious property of mixing with watery vapor in the proportion of 100 to 44 parts, in which form it is not at all easy to condense. Only recently has xylol had a commercial value for color. It behaves with acids much like benzole. A sharp discussion is waging on the composition of this article; the contention being that it is a mixture of other known hydrocarbons.

Cumol (C_9H_{12}) came next—a body also known to exist in resin oil, and may be obtained from cumic acid. It boils at 166° C.; smells rather like garlic; belongs to the paraffin series; forms a sulpho-acid; and is now assuming a value for color qualities it was never thought to possess. Its chief use has been for burning in street lamps, and as a solvent for rubber.

Professor Hofmann—continuing the work by a series of interesting experiments, and by methodical research mapped out by speculative chemical theory (more particularly in regard to the bases of coal tar and the chemical constitution of indigo)—discovered aniline, the very fountain of color. It is impossible to estimate the enormous value of this dis-

* A paper lately read before the North of England Gas Managers' Association.—*Jour. of Gas Lighting.*

† The paper was accompanied by a very interesting exhibition of the numerous products (in the way of dyes, scents, and oils obtained from coal tar) referred to in the course of it.

covery. This is a sample of aniline. Its properties are briefly these: When first prepared it is a colorless liquid, very soon turns yellow, then red or brown; it has no smell; is solid at low temperatures; forms salts with mineral acids; is soluble in water; and crystallizes well.

It was not, however, until 1856 that the coal tar trade felt any impetus from this discovery; and it is to Mr. W. H. Perkin that we owe the credit of utilizing it. This eminent chemist and manufacturer invented a practical process for producing mauve, or aniline purple, of which this is a sample. The intensity, novelty, and beauty of this, the first discovered tar color, not only excited the greatest astonishment and demand for it, but as it necessitated the separation of large quantities of benzole from tar, it marked quite an epoch in the history of the coal tar industry. Previously tar was not worth one halfpenny per gallon in London, while in the country gas makers gladly gave it away. Up to that time distillers simply divided the tar into naphtha, creosote, and pitch; now it had to be much more minutely fractioned, and the products rectified.

Naphtha, as it runs from the tar still, is of a reddish yellow color, has a strong odor, and is much lighter than water, having a specific gravity of about 900, water being 1,000. It is purified by repeated distillations; washed with strong sulphuric acid, with alkali, afterward with water, and then carefully distilled at various temperatures; and thus divided into several parts, each of which, by subsequent treatment, yields a fixed and definite product. These are benzole, toluol, xylol, and cumol. When treated with nitric acid in conjunction with sulphuric acid to sharpen its action, they are converted into nitro-compounds; and these, by the aid of acetic acid, iron, or zinc filings, and steaming, are again converted into aniline, toluidine, xylidine, and cumidine.

At this point a sudden impulse was given to the trade, by the discovery of magenta, or rosaniline. It was found by mixing aniline and toluidine together, and treating them with an oxidizing agent (arsenic acid was first used, but less objectionable oxidizers are now employed), a novel red coloring matter resulted, which was called magenta, but was christened by Hofmann with the more euphonious name of rosaniline. It readily forms salts with acids. Here are some of these—the hydrochlorate, acetate, etc. New processes rapidly followed in the train of discovery for the preparation of mauve, magenta, violet, red, and scarlet, all depending in a great measure on the mixture of aniline and its homologues.

The next important step was taken when it was found that by treating magenta with an organic or fatty acid (for instance soap, which is a fatty acid in combination with an alkali) a beautiful blue dye—aniline blue—is obtained; and by substituting ethyl, methyl, and phenyl radicals for hydrogen in these preparations, by an intricate series of chemical processes all these various shades of colors are obtained. Here are samples. [Mr. Sadler then described in detail the colors mauve, ponceau, green, magenta, lilac, various blues, maroon, yellow, bronzes, olive, and the peacock shades.]

There is no shade of color which cannot now be produced from coal tar; and while it is true that a large trade is still done in extracting dyes from natural sources, the importation and fabrication of colors by the old processes is rapidly decreasing and dying out. The aniline dyes, and those of its homologues, are familiar to every one; and I fear the garb in which you see them now but very faintly shows their exquisite beauty, bewildering variety, and intensity. It would seem as though the delightful colors of the rainbow itself had been caught and applied to charm the eye. A pretty color is said to gratify the sight as much as a lovely melody delights the ear. If this be so, how gratifying it is to think that so much pleasure has been excited by the advent of the numerous family of tar colors, in whose production most here are more or less instrumental. A faint impression of the intense coloring or tinctorial power of these dyes may be gathered from the fact that 1 lb. weight will in most cases, when dissolved, make 100 gallons of vat dye.

In the meantime strenuous efforts had been made to utilize the oily distillates from the tar, and to separate its numerous component parts. Among these was one to deprive the oil of its odor. In the course of experiments in this direction, it occurred to some one to wash the oil with an alkali in solution, and the operator was rewarded by the discovery that the alkaline solution had taken up a considerable quantity of the oil, which was promptly released when an acid was added and the alkali at once neutralized. This body, which has the property of combining with an alkali—comporting itself like an acid in this and other respects—consists of carbolic acid and cresylic acid, possessing extraordinary antiseptic and disinfectant properties. Dr. Angus Smith and Mr. Crookes applied it so successfully in this direction, that the terrible cattle plague which decimated the herds of this country some twenty years ago was arrested by it after everything else had failed. A large demand ensued, and this for a time gave another fillip to the tar trade. Carbolic acid is extracted from the light tar oils by the aid of caustic soda or potash; the lye being neutralized with sulphuric acid. Carbolic acid separates from the liquor in a layer like oil. This is the common commercial product. By distillation and purifying, a colorless liquid is obtained, boiling at 182° C. without decomposition, though on cooling it deposits, or rather solidifies into a mass of white needles, whose uniform melting-point is 42° C. Though not very soluble in water, it readily absorbs moisture from the atmosphere.

These two so-called "acids" are the only products of tar which contain oxygen. They do not redden litmus paper; nor have they any corrosive action on metals. Carbolic acid is a good type of a class which stands as it were midway between alcohols and acids; and as many of the traits of the acid class are absent, I think the name is a misnomer—at any rate it is a misleading and an unscientific one—"phenol" being better. If treated with nitric acid, an important yellow dye is yielded—picric acid. This acid is largely used by dyers; and, as you will see by the sample here, it is rather effective, and I think pretty. This acid again, when heated with cyanide of potassium, gives us isopurpurate of potash—a rich purple dye. Perhaps the most important dye, however, from this source is auriu—an intense coloring material made by acting on carbolic acid with oxalic acid. Many shades, varying from brick red to orange and gold, are dyed by it; and, being a cheap article, it is used largely for common purposes, such as staining paper, printing, and the like. Salicylic acid—a medicine or drug of much importance now a days—is also prepared from carbolic acid. Cresylic acid, always found in conjunction with carbolic, is a colorless refractive liquid. Unlike its twin brother, it does not crystallize or solidify; it is less soluble in water, but behaves much the same with alkalies and acids. Its antiseptic properties are even more strongly marked than those of carbolic acid.

Next in order of distillation comes naphthaline. Some tars contain a large percentage of this hydrocarbon; while in others it does not exist at all, or only in such proportions as to be imperceptible. This is due, to some extent, to differences in the coal used, but chiefly to the temperature employed in carbonizing. All coals yield naphthaline at a high temperature. It is the most evil product of the whole series. From the time when gas manufacturers commenced to distill coal at a high temperature, this volatile and mischievous hydrocarbon has wrought more trouble and provoked more temper than can be well described. It surcharges the tar so that it will not flow, chokes pipes, plugs taps, and is just as offensive as it is possible for anything to be. Nor does its vagaries stop here; but, having finished with the gas manager, it careers on with demoniacal energy to destroy the peace of mind, if not the body, of the tar distiller I have suffered more by the volatile pleasantries and incontrollable pranks of this remarkable substance than I care here to confess. It is the refined spirit of mischief; and, like its class usually is, it is fair to behold. Until within the last two years it was worse than useless, and therefore most difficult to market. A small quantity was consumed for lamp-black purposes; the bulk, however, was used up as fuel. A new era has commenced for it. By treating this refined substance with nitric acid, in a similar manner to benzole and the lighter hydrocarbons, a way is opened to a variety of useful products which are revolutionizing the dye trade. Magnificent scarlets, reds, purples, gold, orange, and yellow are now being made superabundantly from it, and at such cheap rates as the natural and original sources cannot possibly compete with. Cochineal is as sure to be displaced as have the old dye-woods, barks, and roots; and the enormous sums of money annually remitted from this country for the singular little cochineal insect will soon all be kept at home.

These colors are very striking and curious. Take this solution of naphthaline red. By transmitted light it is a charming red; now by reflected light it is a dead brick-red, and appears muddy, though in reality perfectly clear. This peculiar fluorescence is common to several of the other dyes. Here are two very marked in this respect—fluorescin and eosin. You will observe that, by reflected light, the colors are green in one case and a yellow-green in the other; now by transmitted light one is a brown solution and the other pure red. Most of the dyes have in the solid condition quite a different appearance to that when they are in solution. The colors are, however, always complementary to each other. It is a popular prejudice that the beautiful prismatic colors which appear when a thin film of tar is spread upon water reveal at once the superb dyes which are made from it. Of course this is not so; the phenomenon being simply due to the fact that a film of tar on water possesses the property of decomposing light, producing the various colors precisely as seen when a ray of light is transmitted through a prism. A more ingenious, though equally fallacious theory is that, since coal is simply highly compressed charred wood and vegetable matter, the colors obtained from coal tar are condensed sunshine absorbed by the vegetation which luxuriantly flourished in a prehistoric age, millions of years ago. It will be seen that as the sun is the source of light, and as light is a compound of all the elementary colors, the idea has the merit of being novel and entertaining, if nothing else.

Tar and color are so bound up together, that I cannot resist saying something about the latter, in a theoretic sense; and, as it is my hobby, I crave your indulgence while I "trot it round" for your criticism and information. I think it may be useful, however, in considering the numerous derivates of tar having color properties. I purpose astonishing you at the commencement by stating that color does not exist *per se*—*i.e.*, there is no such thing as color—and that the whole thing is an optical delusion. Different bodies have the property of absorbing certain rays of light, and reflecting others. The various colors and dyes which so much delight the vision may, after all, be only the prismatic rays from surfaces endowed with a facility for decomposing light—appropriating some while reflecting others; the rejected rays being the colors that are conveyed to the eye. Color is the name used to express the sensations we feel when light of various rates of vibration is communicated to the vision. The optic nerve records the rapidity of the vibrations set up; and the varying effect on the eye reveals the property possessed by bodies to produce different times of vibration in the light-bearing ether. When white light falls on objects that surround us, it is seldom reflected back to the eye as white light. The bodies or surfaces are illuminated by it; but they have the power of so altering it that they appear to us colored. The white light is really decomposed; certain parts are absorbed, others are reflected. These emitted rays form the color we perceive, and this is invariably the complementary color to that which is absorbed. The products of coal tar possess this property of decomposing light in an extraordinary degree; and my opinion is that its colors and dyes are simply the result of this characteristic property.

Colorless or, as it is termed, white light is said to be made up of seven colors; but any one who has seen much of the spectrum produced by passing a pencil of light through a triangular prism of glass, will agree with me that there is an infinite number of perfectly distinct colors in it. The seven colors—primary, we will call them—red, orange, yellow, green, blue, indigo, and violet, yield a countless host of tints and shades by mixing; they may also be re-combined so as to make white light. I have a little disk here painted in sections of these primary colors—violet occupying one-fourth, orange one-twelfth, the other colors each about one-eighth of the face. When it is rapidly revolved you see the colors entirely disappear. If the proportion of these colored sectors be altered, various other colors are producible. For instance if the red be removed, the color produced is green. The color thus formed is called the complementary color of the one removed; thus green is the complement of red. And as, by the removal of green from the disk, a circle of red results from the whirling combination, red is the complementary color of green. Indeed all spectral colors are complementary. Orange is complementary to blue; and *vice versa*, blue is complementary to orange. Indigo bears the same relationship to yellow, and violet to greenish yellow. Curiously, a red body reflects green rays; while, on the other hand, a green body reflects red rays. Both, therefore, gain in intensity when placed together. Indigo reflects yellow; and, inversely, yellow reflects, indigo rays. Therefore they intensify each other. All the complementary colors behave in the same way—*i.e.*, they complete each other, and gain in intensity when placed side by side.

I have said this much on the phenomena of color, as it somewhat explains the curious and striking property of many of the tar colors to which I have alluded. All the tar colors have, in more or less marked degree, this singular characteristic. An illustration of the prolific nature of tar is seen in the fact that while the first portion of creosote oil largely consists of naphthaline, the last part deposits an entirely different product—anthracene. It usually falls out, as the oil cools, with phenanthrene—a product as yet of no value, but interesting to chemists, who are bestowing a good deal of attention to it just now. I shall not be surprised if very soon some useful discovery concerning it is made. I know one or two eminent men who are submitting it to a crucial research. Phenanthrene is the constant companion of anthracene, and is isomeric with it, having the same composition. Its fusing and boiling points are much below those of anthracene. It forms a nitro-compound with nitric acid, and combines also with sulphuric acid. With picric acid yellow red needles are produced.

Anthracene has done more to increase the value of tar than any of the other constituents. In 1868, Mr. W. H. Perkin in England and Messrs. Graebe and Liebermann in Germany, simultaneously, discovered that alizarine from madder, the original source of Turkey red, could be reduced by zinc dust to a product ($C_{14}H_{10}$) which had the same composition as, and all the other properties of tar anthracene. It was soon found that it was as easy to build up alizarine synthetically from anthracene as to produce the latter from the former by analysis. The crude deposit from the tar oils was purified, and the greasy body I have here was brought into this state, or approaching it. Pure anthracene is a very beautiful body indeed. You will observe that, although it is in reality a white flaky crystal, it has a lovely blue fluorescence in a remarkable degree. Refined anthracene was oxidized with chromic acid, or other convenient oxidizer, into anthraquinone; and then, through a process of substitution, and finally fluxed with soda, alizarate of soda is obtained. By decomposing with an acid, alizarine, or Turkey red (one of, if not the most important dye of commerce), is thus made. Like the other tar colors, it is most deceptive in the solid state; no one would imagine for a moment that there was Turkey red. Here, however, is a solution, and there are some specimens of printing and dyeing by it. Numerous shades of color, from dark blue to bright red, are obtained by varying the mode of application or the mordants used to fix the color. I should add that artificial alizarine is much more intense and reliable for dyeing purposes than the product of madder root.

Some idea of the importance of Perkin's discovery and the industry resulting from it, may be gleaned if we remember that ten years ago the importation of madder, for preparing Turkey red, represented many millions sterling per annum. Great tracts of country—in Algiers, in the South of France, along the Riviera, and in the Levant—and many thousands of people were employed in the cultivation of madder. This is all now practically defunct; the artificial alizarine being obtained purer, more readily, and, what is more to the point, cheaper. Unlike the other tar colors, which are mere imitations or mostly new colors, artificial Turkey red has the same chemical composition as the natural alizarine extracted from madder.

Not much is known of the many oils which are named to us collectively as creosote. The separation, purification, and identification of them belong to the unsolved problems of chemistry. An important insight may be obtained into their character by distilling and fractionating them at different temperatures. Oily products are obtained, varying in color from light yellow to blood red. All are fluorescent. Creosote is made up of a multitude of constituents, and opens up a field for investigation and research that few things can excel. Excepting, however, its general employment for pickling timber, its industrial value is slight.

By continuing the distillation of tar further, a semi-fluid oil comes over. Of high gravity and dense in consistency, it is admirably adapted and used largely in the manufacture of anti-friction grease. These samples were made by an eminent manufacturer in Middlesbrough. Pitch is the residue after all this; and usually this is the end of the distillation process. For, after having cooled in the still for a while, it is run out, sometimes in moulds, oftener in bulk. In this form the greater part of pitch is used for the manufacture of patent fuel—a most important industry in France and Italy, where the coal is soft, and powders in winning. From 7 to 9 per cent. of pitch is ground up with the coal, and the whole, after gently heating, is pressed by hydraulic machinery into square lumps about 9 in. by 6 in. by 4 in. These are called briquettes; and, in this form, fuel is mainly used in the countries named. They will be familiar to most of you. I dare say fuel makers, in their specifications, are particular to state that the pitch shall melt at a temperature under 60°, and have agglomerating power. It is claimed that fuel in this form possesses 10 per cent. more heating power than the best coal. The total production of briquettes is said to be nearly 3,000,000 tons per annum; 80 per cent. of the pitch used being sent from this country.

At one of my works I have for many years run the hot pitch from the tar stills into ovens, and continued there the distillation, until nothing but carbon, or coke, was left. It is a very hard coke, and most difficult of combustion; but, like all refractory fuels, gives an intense heat. Owing to its great purity and freedom from sulphur, metallurgists like it for special purposes, such as for smelting the rarer metals, and for making pure iron. The distillate, sticky and resinous, which condenses, even in hot water, contains: first, chrysen, a bright yellow mass which when dissolved and recrystallized forms loose, shiny golden scales; and, secondly, pyrene, a colorless crystallizable hydrocarbon when freed from chrysen. Both pyrene and chrysen form nitro-products, but up to the present time have not been applied to any useful purpose. From the commencement of the distillation of tar to the end, when coke is left as a residue, ammonia is evolved all through, especially at first and at the finish. This is condensed with the other distillates, and utilized as sulphate, muriate, or carbonate of ammonia.

COLOR MATTERS FROM GAS.

A new and valuable discovery has recently been made by one of my chemists, Mr. Kendall. This gentleman has invented and patented an ingenious process by which he extracts large quantities of color matter from coal gas itself. Remembering that gas tar is the source of so much and so many dyes, it is marvelous no one before ever thought of trying gas itself as a color-source. I have here a sample of the gas color base. From it all the phenylene-diamene colors are obtained. Some specimens of these beautiful dyes are here; Bismarck brown being the chief, and in largest demand. It will enable you to form some idea of the success of this, the most recent invention in dyes, when I tell you that I am at the present time using two million cubic feet of gas weekly, and erecting plant which will shortly be completed, providing a consuming power of five million cubic

feet of gas per week for this purpose. With the object, in the first instance, of economizing fuel at my Middlesbrough works, I convert the coal into a rough gas of about 50,000 cubic feet per ton of coal. I have, through my engineer, patented a new gas generator, which is so constructed that both tar and ammoniacal liquor are caught in quantities as large as, if not larger than from coal carbonized in a retort. The generators each gasify about six tons of coal per day, and the admission of air is so dexterously controlled that the tar is not destroyed. By an arrangement of ejectors, compressors, and condensers, both tar and ammonia are eliminated from the gas and collected. The tar is, I admit, inferior in quality to that made in gas works. I am sure it will interest, though I doubt whether it will please you, to hear of this new source of tar.

While in this direction, I may inform you that Messrs. Pease, of Darlington, are now completing an extensive plant, on a French patent, which has been successfully at work in France for several years, by which they expect to catch the tar and ammonia from their coke ovens. Messrs. Baird, of Gartsherrie, the largest iron makers in Scotland, have also devised appliances whereby they condense tar and ammonia from the gases as they leave the blast furnaces. In Scotland coal and not coke is used for smelting iron, as is the case here.

What effect the advent of all this tar and ammonia into the market will have on the value of them, it is impossible to tell. For myself, I cannot say that I view the position unmoved and without trepidation. At this moment there is more tar made than is required for present known uses. Anthracene, for instance—the mainstay of the value of tar—which has for years maintained an average price of about £100 per ton, is now unsalable at £30 per ton. Carbolic acid again is even more unsatisfactorily situated, being without a market at one-fourth of the price of former years. But enough. What will happen, must. *Nous verrons.*

That coal tar—a dirty, repulsive-looking article—should have become such a prolific source of color and useful products is one of the most striking illustrations of modern scientific discovery coupled with commercial enterprise. Although of such youthful years, I have shown that it is the progenitor of a very large family indeed; and, unlike their parent, the offspring is often very beautiful, and always interesting.

Discussion followed.

Mr. Harding (Sunderland) said that last week he (Mr. Harding), by invitation, went to Messrs. Baird's works, and he there saw in active operation the process by which they obtained from the blast furnaces thirty pounds of sulphate of ammonia and fifteen gallons of tar per ton of coal thrown into furnaces. The difficulty attending condensation, owing to the gas evolved from the furnaces being twelve times the volume of the gas evolved in ordinary gas works, had been overcome; and, within twelve months, the firm would have the apparatus fitted to the whole of their furnaces. The estimated cost of fitting one furnace was £5,000, and this cost would prevent ironmasters, for many years, from carrying out the process; but the profit arising from the condensation of the gas amounted to no less than from £10,000 to £12,000 per annum for each furnace. The firm altogether had expended some £40,000 or £50,000, but they anticipated that within the next eighteen months they would be recouped quite £150,000. The sulphate of ammonia collected was, he might say, equal to any sulphate made in the United Kingdom. With regard to the tar, it made very good pitch and it had also a good oil, some of which he had now under distillation in his laboratory at Sunderland.

Mr. Sadler, in reply, said he believed that what Mr. Harding had stated was substantially correct. The Middlesbrough ironmasters looked upon the process named with very great fear. They were not involved in smelting the iron with coke, and they would be very clever indeed if they extracted ammonia and tar on their own premises.

TESTING THE COMMERCIAL VALUE OF CARBOLIC ACID.

By Dr. O. BACH.

OF the various methods in use for determining the quantity of phenol in crude carbolic acid, the one which depends on its conversion into sulphocarbolate, and which was first recommended by Schoedler (*Pharm. Centralh* xiii, 225) and afterward by Nietsch (*Ann. Chem. Pharm.* xl. 587), cannot be employed because it is too tedious, and besides it is difficult to make the mono-sulphocarbolate. Shaking the acid with caustic soda solution leads soonest to the desired end. There is, however, this difficulty in the way—if it is shaken at once with the alkali, that in thick, sirupy, and dark colored liquids, it is difficult or impossible to distinguish the separate layers, and also that the oily layer of tar does not separate readily from the layer of carbolate of soda, even when it is put in hot water, and by doing this there is formed an intermediate layer—a sort of an emulsion—between the two, so that an accurate reading is impossible.

In addition to this it very frequently happens that the acid to be tested contains a considerable quantity of water, 20 per cent or more, which must lead to false results if direct readings are made, and hence it would be necessary to estimate the quantity of water.

To avoid these evils, and to be able to carry on an estimation of the water and phenol in the same sample at the same time, I proceed as follows: I distill 50 c. c. of the acid to be tested in a retort, continuing the distillation until solid hydrocarbons begin to form in the condensing tubes. The distillate is collected in a 100 c. c. burette, graduated in one fifth c. c. with a glass stopcock soldered to the lower end. Before beginning the distillation about 25 c. c. of a saturated solution of table salt is put in the burette, and the level carefully read and noted. If the acid under examination is free from water, the distillate will float on the brine as a clear layer, while in the other case the oil, water, and brine will form an emulsion. When the distillation is concluded, the burette is corked and gently shaken, when the oil separates quickly and sharply from the salt solution. The increase in the volume of this latter gives the number of cubic centimeters of water present in the acid, and from it the percentage is readily calculated.

To determine the quantity of phenol, it is necessary to remove the solution of salt as completely as possible, for when it is subsequently shaken with caustic soda, if there is any salt present the carbolate of soda separates in flocks, making an accurate reading difficult. After removing the cork and reading the volume of the oil, the stop-cock is very carefully opened to let the brine run out. If the cock is opened too far there is danger on the one hand that some of the salt solution will stick to the side of the burette, and on the other that some oil will be lost when it reaches the narrow part of the burette. After the salt solution has all been removed the burette is filled to the zero-point with a soda solution of about 30° B., a cork inserted, and the mixture well shaken and left to settle. If the burette is free from grease, the oil separates quickly and sharply, and by turning the burette gently about its axis once the oil or water drops that adhere to the sides can be wiped off, so that in half an hour the number of c. c. of oil that remain can be read. The difference in the volume if the oil before and after shaking with soda equals the volume of phenol, which may be easily converted into per centages.—*Ch. Zeit.*

MICROCHEMICAL REACTIONS.

By Dr. A. TSCHIRCH.

THE microscope is specially useful for recognizing the characteristic properties of objects. For instance, it is impossible to distinguish the different kinds of starch without a microscope; but one glance through the lens will tell the name of the starch. The fibers used in spinning, though differing but little microchemically, are easily recognized by their morphological characters. Many adulterations of coffee, tea, spices, etc., are easily detected in this way. The distinction of hem and flax is difficult, but Cramer has succeeded in finding a characteristic and unerring guide in the long cells with red contents that accompany the bast cells of the hemp. The width and thickness of the beard of wheat and rye differ sufficiently to enable one to decide between them.

The domain of pure chemistry also possesses an essential aid in the microscope. The hæmatine reaction which is decisive for blood stains, the distinction between the different constituents of urinary deposits, between quinine and cinchonine, and even between strychinine and atropine, is easy and certain when the crystalline forms are viewed through a microscope.

THE STARCH TEST.

The earliest microchemical reaction employed was, indisputably, the iodine and starch test discovered by Stromeyer, which vies in sharpness with the barium test for sulphuric acid in inorganic chemistry. By this means it was possible, at an early date, to obtain an insight into the *topographical division* of the starches, and to recognize the cells and cell complexes in which this reserve of nutriment occurs, and the courses that it pursues.

THE CELLULOSE REACTIONS.

The iodo-chloride of zinc reaction, which colors pure cellulose a violet blue, and the iodo-sulphuric acid reaction, which dissolves it with a blue color, belong to the most important microchemical reactions. In these we possess an easy and practical method of distinguishing vegetable fibers from animal fibers, for only the membranes of plants exhibit the properties just mentioned, and these only with certain limitations. For example, membranes that are incrusted with lignine cannot be subjected to this test until the incrusting substances have been removed by maceration with nitric acid, alkalies, or Schulze's maceration liquid.

Another valuable reaction applicable only to pure vegetable cellulose is the solubility in the ammoniacal solution of copper oxide. This reaction was discovered by Schweizer of Zurich and fully described by him, after which Cramer followed it out further and described the peculiar changes of form observed when the objects swelled up.

SCHULZE'S MACERATION PROCESS.

After the iodine reaction the next important advance was Shulze's method of isolating single elements of tissues. His maceration process consists in treating the tissue with nitric acid and chlorate of potash, its object being to isolate the separate cells by dissolving out the intervening substances. It is intermediate between macro and micro chemistry.

Some time before, Pringsheim recommended nitric acid alone for this purpose, but his suggestion did not attract any attention as the publication was not easily accessible, and Schulze's process first found acceptance and renown. In technical microscopy this maceration process may be very extensively employed, for cases very frequently occur where single elements are to be examined in larger portion of tissue. But it must not be forgotten that measurements of the diameters of cells, such as bast cells, which have been subjected to maceration cannot be relied upon, because the reagent causes the cells to swell considerably.

This reagent is very useful for separating what Jönsson calls the *ophiur* cells which are found in tea leaves, and are characteristic of a number of camellias, but are totally wanting in the leaves generally used for adulterating tea. Also for isolating the bast cells from fibers that consist more or less of bundles. In addition to isolating cells, this reagent has another valuable property, namely, of dissolving and removing the strongly colored incrustations of the cell membranes, both of natural objects like cinnamon and cinchona bark, and of roasted articles like coffee, thus making the articles lighter in color—which is very important in testing coffee, for example. Ammonia and caustic potash have the same action. Unfortunately measurements cannot be made after treatment with any of these reagents, but in most cases a knowledge of the characteristic morphological distinctions is sufficient, but in a few cases—as in textile fibers—measurements are indispensable, and here the fibers must be picked apart with a needle.

CAUSTIC POTASH.

This is likewise a very important micro-chemical reagent. It has just been mentioned that one can employ it with good effect for clarifying the tissues. While the histologist renders whole tissues and even whole organs transparent (such as embryos) by the use of this reagent, it plays a still more important part in clarifying roasted mixtures, which, if they are not sufficiently transparent after treating with Schulze's maceration liquid, are easily made so by the use of potash. There are two methods of using it; Haustein's method consists in successive treatment with caustic potash and acetic acid, while Russow's makes use of alcoholic potash; which has the advantage that membranes do not swell up to such unshapely masses in this as they do in pure potash.

STARCH IN COLORED SUBSTANCES.

Böhm was the first to show that by combining the use of potash with the iodine reaction it was possible to detect small quantities of starch in colored substances where it would otherwise escape detection, as in chlorophyl granules for instance.

THE SUGAR TEST.

One of the most brilliant achievements of micro-chemistry is Sachs' application to physiologico-histological investigation of Trommer's sugar test, in which potash also plays a part. Sachs has proved that by means of this test both cane and fruit sugar, as well as other members of this group, such as dextrine, can be detected under the microscope even in the cells themselves, and with a little experience may be estimated quantitatively. The method used by Sachs is as follows: He first dips the section in copper sulphate solution, then washes it in water, and boils it for a short time in a dilute solution of caustic potash. The characteristic precipitate of red suboxide of copper is produced within the cells that contain sugar. This test, of course, requires some practice, for if the copper sulphate is not sufficiently washed out the black oxide of copper (cupric oxide) is precipitated and conceals the red oxide (cuprous oxide). On the other hand when the washing is carried too far the easily diffusible sugar passes through the cell walls by endosmosis into the wash-water, and can no longer be detected in the spot where it naturally occurs. Nevertheless we may hope, when this method is perfected, to get on the track of the migrations of the sugar, to which many of the phenomena observed in the changes in matter are to be referred.

TANNIN REACTION.

The peculiar red color that caustic potash imparts to cells that contain tannin of course leads us next to the test for tannin, which is also valued as a macro-chemical reaction.

STAINING.

The lengthy chapter of staining can only be mentioned here. It offers a well known and important aid in the study of animal tissues, and especially in the investigation of bacteria.

Most of the micro-chemical reactions known at present naturally refer only to substances that are not characterized by any chemical tests, and which are recognized only by the peculiar changes of color that they suffer when certain reagents are applied, while we are absolutely in the dark in regard to the nature of the colored substance which is formed during the reaction. There is still a large field left for investigators in pure chemistry—but for technical microscopy a knowledge of these color changes is at present sufficient.—*Chemiker Zeitung.*

POISONOUS LEAVES.

SOME of our most admired flowers, which we should least willingly banish from cultivation, are associated with green leaves of a very poisonous character. The narrow, long leaves of the daffodil act as an irritant poison; the delicate compound leaves of laburnum have a narcotic and acrid juice which causes purging, vomiting, and has not unfrequently led to death. The narrow leaves of the meadow saffron, or autumn crocus, gave rise to the utmost irritation of the throat, thirst, dilated pupils, with vomiting and purging. The dangerous character of aconite, or monkshood leaves, is doubtless well known, but each generation of children requires instruction to avoid above all things those large, palm-shaped leaves, dark green on the upper surface. Leaves of coarse weeds provide an abundant quota of danger, but frequently their strong scent and bitter or nauseous taste give timely warning against their being consumed. Of all our British orders of plants perhaps the umbelliferous order contributes the rankest and most widespread elements of danger. The tall hemlock is everywhere known to be poisonous, and it is one of the most abundant occupants of the hedge. A peculiar "mousy" odor can generally be recognized on squeezing the leaves, which are deep green in color and trebly compound, the small lobes being lanceolate and deeply cut. It is said that the mousy smell can be detected in water containing not more than a fifty-thousandth part of the juice. Hemlock is both an irritant to any sore place and a general narcotic poison, producing headache, imperfect vision, loss of power to swallow, and extreme drowsiness, with complete paralysis of voluntary muscles and muscles of respiration. The water dropwort, too, a flourishing ditch plant; the water hemlock, fool's parsley, must be ranked among our most dangerous poisonous plants belonging to the umbelliferous order. The fool's parsley leaves are sometimes mistaken for genuine parsley, but their nauseous odor and darker leaves should prevent this. The nightshade order is another, with dangerous and often extremely poisonous leaves. Indeed, no nightshade can be regarded as safe; while the deadly nightshade, with its oval, uncut leaves, soft, smooth, and stalked, is in the highest degree to be avoided. Henbane and thorn-apple, again, with their large and much-indented leaves, are conspicuous members of the "dangerous classes." Holly leaves contain a juice which is both narcotic and acrid, causing vomiting, pain, and purging. Even elder leaves and privet leaves may produce active and injurious irritation when eaten. With regard to treatment in cases of poisoning by leaves, if no doctor is at hand, produce vomiting till all offending matter is expelled, and, when considerable sleepiness or drowsiness has come on, give strong tea or coffee, and again bring on vomiting; then stimulate and rouse the brain in every possible mode.—*Land and Water.*

THE ASH AND ITS VARIETIES.

THE common ash (Fraxinus excelsior) and several of the North American kinds rank high as timber-producing trees, their wood, owing to its elasticity, being much sought after where strength and toughness are wanted. Apart, however, from their value in this respect, the different forms offered plenty of scope to the planter, some being large, noble looking trees, others comparatively small, and a few singularly grotesque. The recognized varieties of the common ash are many, some of the most distinct being the weeping kind (pendula) so often employed for forming arbors; of this there is also a golden form (pendula aurea), the bark of which is bright yellow, but in other respects, except being of somewhat weaker growth, it resembles the common weeping ash. Another kind (F. excelsior heterophylla), of which we append an illustration, is remarkable on account of the absence of leaflets, and instead one large, simple, deeply serrated leaf. It forms a tree nearly as vigorous as the common kind, and is often known by the name of the one-leaved ash (monophylla), certainly a better name than heterophylla, the leaves being seldom variable. Of this there is a form in which the leaf is deeply slashed instead of serrated. The cockscomb ash (F. excelsior cristata) has often a large proportion of the shoots curiously fasciated, especially at the points, where they spread out in a cockscomb-like manner. This is but a slow-growing tree, and frequently some of the branches die off without any apparent reason. A dwarf, bushy kind, F. excelsior globosa, assumes the shape of a small, round bush, and when grafted standard high has a mop-like appearance. Other varieties in addition to those

just mentioned are, crispa, a dwarf form with very deep green and much curled leaves often encircling the stem; the gold and silver variegated, neither of which are very effective when exposed to wind and sun; aurea and jaspidea, with bark yellow and striped; angustifolia, a kind in which the ordinary leaflets are reduced to mere filaments; and verrucosa, a variety with rough and verrucose bark.

The small leaved ash (parvifolia), a European species, is

FRAXINUS EXCELSIOR HETEROPHYLLA.

less in all its parts than the common kind. It forms a low, much-branched tree, and one that from its spreading, yet twiggy, head is very distinct and pretty. Under the name of xanthophylla is sometimes found a very neat little ash, which seems to be a variety of parvifolia. It is of bushy growth, densely twiggy, and the whole leaf, which is only about two inches long, is very deep green.

The lentiscus-leaved ash (F. lentiscifolia) need not be con-

FRAXINUS AMERICANA CAROLINIANA.

founded with any of the preceding, being altogether very different. It is a medium-sized tree of somewhat upright habit, the leaflets narrow, and the leaves themselves thinly arranged on the branches, so that it has a lighter appearance than the others. There is also a pendulous variety of it, fully as weeping as the ordinary kind, and one that forms a good companion thereto.

The different sorts of American ash very much resemble

FRAXINUS EXCELSIOR.

each other, and, roughly speaking, they may be all said to be free, vigorous kinds, with fewer and more spreading branches than the common one, and bearing larger leaves. Another distinction, though less decided, is the paler hue of most of them, especially in foliage. F. americana, the white ash of the United States, may be taken as the type of most of the American kinds, and one that shows prominently the distinctive characteristics just mentioned. It possesses a wide geographical distribution, and, like most plants extensively distributed, varies a good deal according to locality. A few of the most distinct varieties, or, as contended by some, separate species, are the elder-leaved or black ash (F. sambucifolia), the leaves of which, instead of being entire or nearly so, are serrated, and altogether bear a general resemblance to those of the elder. The green ash (F. juglandifolia or viridis), so called from the color of the young shoots, is the most distinctive and ornamental of its section, the leaves when growing freely being almost as large as those of some of the Caryas. The Carolina ash (F. caroliniana) in general appearance resembles a smaller form of the above except that the leaves are rather more erect. In F. pubescens the leaflets are somewhat tomentose beneath and quite entire, while in F. rufa they are deeply serrated. Both kinds are less vigorous and more spreading in habit than the ordinary American ash. There is also a variegated variety (F. aucubæfolia), the leaves of which are irregularly blotched with gold, and as the color is not affected by sunshine, and as the variegation does not exist to such an extent as to impair the constitution of the tree, it is useful for planting by way of contrast to other and more sober hued kinds. The blue ash of Michigan (F. quadrangulata, or tetragona, as it is sometimes called) is a bold, regular-growing tree, remarkable on account of the tetragonal arrangement of the branches, and also from the fact that along the young shoots extend four raised lines, which, being opposite each other, give the shoots the appearance of being nearly square. As they get older this squareness becomes very much less prominent, until in three or four years it disappears altogether. The older bark is also quite distinct from that of the others; it cracks and splits in a manner totally different from any of them.

The genus Fraxinus is represented in Japan by F. longicuspis, which, judging by young trees of it in England, is much like a free-growing form of the common ash, but of a paler hue; in Turkestan, by F. potimophila, a small, dark-looking kind; and in Manchuria by F. manchurica, the foliage of which is large and bold in character. Where seeds are produced the various kinds of ash are readily propagated in that way; but as regards the different varieties, it is necessary to graft or bud them on the common kind. Grafting is generally performed, as in the case of fruit trees, in spring, when the trees are still dormant, and budding about July.—*The Garden.*

CULTIVATED SPECIES OF INULA.

INULA GLANDULOSA.—The handsome hardy perennial, of which a woodcut is here given, is a native of Georgia (in Asia), and flowers in June. It was given to me by Mr. Alfred Walker, in whose garden at Chester it flowers well and increases fast. It requires no special soil or treatment. The color is bright orange-yellow. The flower is very ornamental, the long rays hanging round the prominent disk in a way which always reminds me of the firework called a "tourbillon." Though the plant is correctly described and figured in Loudon's "Encyclopædia," where we are told that it was introduced in 1804, there appears to have been some confusion between this and I. Oculus-Christi in the naming, for both at Kew and at Chiswick I saw that species, which has small, shabby flowers, labeled I. glandulosa. Other species of Inula cultivated in the garden at Edge Hall are:

FLOWER HEAD OF INULA GLANDULOSA; COLOR, BRIGHT YELLOW. (Natural size.)

I. HELENIUM (Elecampane), a native, with handsome, stiff, dark green leaves, glaucous beneath, sometimes measuring three feet in length and one foot across. It makes stiff, branching flower stalks, six feet to eight feet high, with rather ragged yellow flowers, three inches across. The plant is handsome for rough shrubbery borders or for naturalizing near ponds and in moist places, though water rats are apt to eat it down. It grows finer, however, where the soil is open and tilled.

I. MACROCEPHALA bears its flowers singly, one on a stalk about three feet high. Flowers orange-yellow, with handsome downy-toothed bracts; the rays are so short as to give the flower the appearance of being imperfectly developed, and makes it rather disappointing.

I. ENSIFOLIA—A dwarf neat kind, with narrow, smooth leaves and stalk one foot high, each bearing a single yellow flower of good shape.

I. HIRTA grows about the same height as the last, but has broad, rough leaves and rather larger, but less elegant flowers.

I. VAILLANTI.—Flowers and leaves resembling those of I. ensifolia, but taller, and having a branching stem.

All these plants may be divided late in autumn, each stalk being separately rooted, and having young shoots at the base. They grow in any garden soil.—*C. Wolley Dod, in the Garden.*

NEVADA FOSSILS.

SPEAKING of the attention drawn to the fossil foot-prints in the State prison quarry, at Carson, Nevada, the Virginia *Enterprise* suggests that geologists should take a look at the tracks beyond Dayton, near the mouth of El Dorado Cañon. The tracks are in rock, apparently the bed of an ancient lake. Petrified wood is abundant in the same region. The *Enterprise* says:

In 1860 we found a petrified log of pine some 30 feet in length and 18 inches in diameter, on the side of a hill to the southeast of American flat. Strewn over Spring Valley there was also at that time much petrified cedar, fir, pine, and other kinds of wood. The prospectors were in the habit of "sledging" these logs up in order to get at the knots, pieces of pitch, and other parts that would make handsome specimens for cabinets. These logs were, no doubt, the trunks of trees that had floated about on the ancient lakes until they became water-logged and sank to the bottom. The random way in which they were found scattered about seemed to show this.

In the year 1861 a big flood washed out a great number of petrified stumps of trees along a ravine running from near the

old Daney mine, Spring Valley, down to the Carson River. These appeared to be the stumps of cottonwoods, alders, and such trees as grow along streams. The roots and all parts of these stumps were perfectly petrified.

In this region, however, nothing more interesting is likely to be found than appears on the surface; but, further down the Carson and to the eastward of the Sink, is a section of country that would be likely to yield much of value to the careful scientific investigator. There is in that region a large area of recent sand-rock, of coarse, loose texture and a granite-gray color.

Some four miles east of the sink of the Carson, an upheavel of granite has so raised the sedimentary formation as to show it to be about 800 feet in thickness. In many places large cañons have cut through this formation, leaving nearly perpendicular walls. In passing along the cañons, without making any special examinations, we have found, sticking in the walls, bones of small animals and birds, bits of wood, twigs, and the like, all black, as though carbonized.

On the bank of a deep cañon, northeast of what is known as the Lower Sink of the Carson, is a place where is to be seen a great quantity of petrified wood of all kinds. A stratum of this wood, some five feet thick, and exposed along the cañon for a distance of over 100 yards, appears to have been a great drift. All is so thoroughly petrified, and so natural in appearance that, at a distance, it seems to be a lot of cordwood stacked up on the bank of the cañon. Mingled with this petrified drift-wood, may, perhaps, be found the bones and skeletons of animals, birds, and reptiles. The bed of petrified wood is covered to a depth of from three to five feet with earth and gravel.

ANIMAL INTELLIGENCE.*

FROM the time of Locke downward the question, How far have animals the power of abstraction? has often been discussed. Locke himself maintained that "the having of general ideas is that which puts a perfect distinction betwixt man and brutes, and is an excellency which the faculties of brutes do by no means attain to." And this view is warmly advocated by Prof. Max Muller and other living thinkers. On the other hand Mr. Romanes, who has made the subject of animal intelligence a special study, writes: "Give a cat or a dog some kind of meat or cake which the animal has never met with, and the careful examination which the morsel undergoes before it is consigned to the mouth proves that the animal has properly abstract ideas of sweet, bitter, hot, nauseous, or in general, good for eating, and bad for eating, *i.e.*, abstract ideas of quality as apart from the object examined—the motive of the examination clearly being to ascertain which general idea of quality is appropriate to the particular object examined." (*Nature*, vol. xx., p. 123.)

Our first duty in a case like this is to make quite sure of the meaning of the words we employ. Much confusion may be, and has been, introduced into this subject by a lax use of words. Let us consider, then, the several meanings which these terms abstraction and abstract idea may have.

In the first place it seems to me that our most ordinary impressions involve abstraction. An object is capable of affecting us in a number of different ways, but of all these at any given moment we only pay attention to one or two which happen to interest us. The rest are practically nonexistent for us. The mind automatically rejects or eliminates them. This is certainly a process of abstraction, but for the sake of clearness I venture to call it *elimination*. By means of elimination we get definite, clear-cut mental impressions.

In the second place our general conceptions involve abstraction. A general conception is one which does not stand for a particular object, but for a group of objects. It is arrived at by abstracting the essentials and neglecting the unessentials. In the great number of dogs I see around me, there are certain essential characters in the midst of some diversities. As I consider them in the mass, however, the diversities cancel each other in my mind, and I obtain a general conception of a dog. We may for the purpose in hand call this process *generalization*. The product is *not* a definite and clear-cut image.

In the third place, I may by a process of abstraction consider a quality apart from the things that possess that quality—whiteness for example, apart from white objects, edibility apart from edible things. We will here retain the term abstract idea to denote such qualities, and we will for the present term the process by which they are obtained *isolation*. Of a completely isolated quality no mental image can be formed.

That dogs and the lower animals in general make use of the process I have above termed elimination, cannot, I think, for one moment be doubted. For if they do not, then we must suppose that they are able mentally to grasp an object in the entirety of its qualities, which is more than the average human being can do. Let us suppose that a dog sees what he believes to be a soaked dog-biscuit. The impression he receives through his eyes at once suggests certain possible olfactory impressions and certain possible gustatory impressions. This of course implies what is commonly called the association of ideas. But there are other possible impressions which might be suggested but probably are not, such impressions, for instance, as may be produced by the hardness, temperature, and weight of the object. These impressions are not suggested, they are eliminated, so to speak. In other words, certain possible impressions are abstracted from certain other possible impressions. Suppose, now, the dog proceeds to smell the biscuit that he has hitherto only seen. If it answers to his expectations he at once begins to eat it. His nose tells him that it is good for eating. If, however, it does not answer to his expectations, if, perhaps, it has received the drippings of a paraffin tin, he turns sorrowfully away. His nose tells him that it is not good for eating. One kind of smell suggests that the biscuit will be pleasant to the taste; another kind of smell suggests that it will be unpleasant. And the dog, unless he be a very young one, having confidence in his nose, acts upon the suggestions without verification. It is to these suggested impressions that Mr. Romanes applies the term "abstract ideas of quality, as apart from the object examined." And I do not suppose that any one is prepared to deny our dumb companions abstract ideas *in this sense of the term*.

Let us now consider how far we may suppose animals to posses the power of generalization in the sense in which I have above used this term. A dog lying asleep upon the hearth-rug hears outside the window an unusual footstep. He at once pricks up his ears and gives a half suppressed growl. Must we not suppose that in such a case as this the footstep suggests to the dog the idea of a strange man? And if so, will not the suggestion—of whatever character it might be—be general rather than particular? If it be a mental picture—and we are often told that dogs think only in pictures*—must not the picture be generic in its character, like Mr. Galton's composite photographs of the average blackguard? And if it be a symbol of some kind, must it not be a symbol that stands for strange man in general, since there is nothing to suggest any particular strange man? But if this be so, and if a general conception is one which stands not for a particular object, but for a group of objects, I do not see how we can deny general conceptions, in this sense of the word, to our four-footed friends. And if the word abstract idea stand, as it is sometimes made to do, for general conception, we must admit, I think, that such abstract ideas are possible for the brute.

We come now to such abstract ideas as result from the process I termed isolation. Are these, too, possible for the brute? I have only to say that it has always seemed to me that when we speak of being able to form abstract ideas of redness, emptiness, justice, and the like, all we can possibly mean is that we can make use of the *words* as symbols in a train of thought. I have only to say this to indicate the nature of my answer to this question, I believe such abstract ideas to be impossible for the brute, I believe them to be the outcome of the use of language. We see a plum, and we find that it is round, and blue, and resisting. From these words we form abstract nouns, roundness, blueness, resistance. We then proceed to manufacture a something to which each of these words may answer, and we call that something a quality. Having thus made the quality, the next thing we do is to try and endow it with a separate existence, and to the results of our endeavors we give the name abstract idea. All this is a process which grows out of our use of words under the influence of a developed power of reflection; it is an attempt to conceive a reality-in-thought answering to certain of our symbols. Without a considerably developed use of symbols such a process is impossible. Hence I believe that no animal can form an abstract idea in this sense of the term. He does not possess the only possible means of doing so. To form such abstract ideas as these, is certainly "an excellency which the faculties of brutes do by no means attain to." Here we may agree with Locke and his followers.

May we say, then, that the power of forming abstract ideas, in this sense, is that which distinguishes the intelligence of man from the intelligence of the brute? I think not. There are, I believe, among the lower races of man, whole tribes which are unable to form abstract ideas. Abstract ideas are made possible by language, but the use of language does not necessarily imply the ability to form abstract ideas. Philologists tell us that there are languages or dialects in which no abstract words are to be found. This, however, is certain, that there is no known savage tribe which has no language. Man is the one being that can make use of spoken signs.

But it may be said that, although their language differs from ours, animals too have their language, imperfect it is true, but still a language of their own, a means of communication with their fellows. And this is perfectly true. It is true, too, that my dogs can understand *my* language. But all that a dog can communicate to his fellow—all that I can communicate to my dog is a sign which he has learnt to associate with certain feelings or with certain actions to be performed. The communication deals, too, with immediate feeling or action; its sphere is the here and the now. There can be no doubt that dogs associate with barking in certain tones, special emotional states in their companions. In fact it is probable that dogs can in this way communicate with each other a wide range of states of feeling. But these states are present states, not states past or future. They are their own states, not the states of others. A dog can call his companions' attention to a worriable cat, or he may have his attention roused by my exclaiming "cat." But no dog could tell his companion of the successful "worry" he had just enjoyed, or suggest that they should go out for a "worry" to-morrow morning. And here we come upon what seems to me the fact which raises man so immeasurably above the level of the brute. *The brute has to be contented with the experience he inherits or individually acquires. Man, through language spoken or written, profits by the experience of his fellows.* Even the most savage tribe has traditions extending back to the father's father (Sprout). And the civilized man—has he not in his libraries the recorded results of many centuries of ever widening experience and ever deepening thought? Thus it is that language has made us men. By means of language and language alone has human thought become possible. This it is which has placed so enormous a gap between the mind of man and the mind of the dog. Through language each human being becomes the inheritor of the accumulated thought and experience of the whole human race. Through language has the higher abstract thought become possible.

But though I look upon the difference between human intelligence and brute intelligence as very great, *I do not believe that there is any one faculty which all men possess and which no brute possesses.* I have already stated my views on the subject of abstraction, and to what I have said I have nothing now to add. But concerning the converse process of *construction* or object forming a few words may be said. Let me first explain what I mean by construction. Our conception of an object is the result of a synthesis of its qualities. But this synthesis is, I imagine, of two kinds. There is a synthesis by immediate association, and a synthesis by reflection. When a dog sees before him a soaked dog-biscuit his conception of the object is a synthesis by immediate association. The sight of the biscuit at once suggests by association a certain smell and taste. The object he mentally constructs is built up of these three—sight, smell, and taste. All other properties are rejected or eliminated. Now, suppose the dog capable of reflecting thus—the biscuit is light enough to carry, soft enough to bite, cool enough not to burn my mouth—he would then add to his synthesis by immediate association, a further synthesis by reflection, and would construct a more complete object. By the synthesis by reflection, in fact, all those qualities are added which are unconsciously eliminated in the immediate construction by association. I do not imagine that brutes have sufficient power of reflection to affect to any great extent this further synthesis. Indeed I imagine that savages and young children do not habitually go further than the construction by association. The further process has been added mainly under the influence of a developed language. The *word* groups around itself not only the cluster of associated ideas which make up the ordinary unreflecting conception of the object it symbolizes, but also those further ideas which are the result of scientific study. The word is the peg upon which we hang those abstract qualities which by means of words we have isolated.

C. LLOYD MORGAN.

* From a lecture delivered in Cape Town, South Africa.—*Nature*.

* I do not know that I quite understand what thinking in pictures means, but I should imagine that sounds and smells entered pretty largely into the current of canine thought. And on the other hand, I should be disposed to think that Spenser and Shakespeare possessed in no slight degree the power of thinking in pictures—pictures far truer and more beautiful than even they could describe in words. All processes of thought, in fact, are carried on by association. And in the chain of association there may be links of all kinds furnished by all the senses we possess. All that we can say with regard to man is that he adds to the natural symbols which form links in this chain of association, certain arbitrary symbols of his own manufacture.

THE PLATEAU OF MID-ASIA.

AT the recent meeting of the British Association there was a large gathering in the geographical section, to hear the address of Sir R. Temple, the President, dealing with the central plateau of Asia.

He said: This area, which is one of the most wonderful on the surface of the earth, contains nearly 3,000,000 of English square miles, and is equal to three-fourths of Europe. Its limits, its exterior configuration, its central and commanding situation in the Asiatic continent, will be clearly perceived from the large diagram of Asia which is exhibited here. As compared with some of the more favored regions it is singularly destitute of natural advantages. Though it has several deep depressions of surface, yet its general elevation is very considerable, and some of its large districts are the most elevated in the globe. It is walled in from the outer world and excluded from the benign influences of the sea by mountain chains. Its climate then is very severe on the whole, more distinguished for cold than for heat, but often displaying extremes of temperature high as well as low. It offers, from the character of its contour, extraordinary obstacles to communication by land or water. Though seldom inaccessible to courageous explorers, it is generally hard of access, and in several respects very inhospitable. In the progress of civilization it is, with reference to its historic past, excessively backward. Its capacities for the production of wealth have been but little developed. Its population is scanty, scattered, and uncultured. Its agriculture comprises only a few areas widely segregated from each other, and many of its largest districts are amazingly desolate. Nevertheless this plateau has eminent claims on the attention of geographers, for several reasons, which may be summarized thus:

1. A mountain system, which dominates the greater part of Asia, and includes stupendous ranges with the loftiest peaks yet discovered in the world. 2. A series of heights and depressions, almost like the steps of a staircase, within the mountainous circumvallation of the plateau. 3. The source and the permanent supply of rivers which, passing from the plateau, flow through densely populated regions, and help to sustain the most numerous families of the human race. 4. A lacustrine system, comprising lakes of which some are saline while others have fresh water, and of which many are situated at great altitudes. 5. The home of conquering races, whence warrior hordes poured during several centuries over nearly all Asia and a large part of Europe. 6. Natural products of value, variety, or interest, and pastoral resources susceptible of indefinite development. 7. An enormous field for scientific research, with many regions which, though not wholly undiscovered, yet need much further discovery. 8. An imperial jurisdiction offering many problems for the consideration of social inquirers.

I shall now offer a brief explanation regarding each of the eight points stated above. In the first place it will be seen from the diagram that the plateau, in shape somewhat of an irregular rhomboid, is completely inclosed by six grand ranges of mountains, namely, the Himalayas, looking south toward India, the Pamir, looking west toward Central Asia, the Altai, looking north toward Siberia, the Yablonoi, looking northeast toward Eastern Siberia, the Yun-ling and the Inshan (inclusive of the Khingan), looking toward China. These several ranges preserve generally a considerable altitude, varying from 6,000 to 25,000 ft. above sea-level, and reaching in the Himalayas to more than 29,000 ft. The tallest of these summits have been accurately measured by the Great Trigonometrical Survey of India. Their altitude is about double that of the highest mountains in Europe, and surpasses any altitude yet observed in any quarter of the globe. But as a great part of these several ranges is as yet unsurveyed by trigonometry, it is possible that still greater heights may be discovered, and that "excelsior" may be the proud answer rendered by the everlasting hills to human investigation. Regarding these and the other chains yet to be mentioned, it must be borne in mind that there are many cross ranges and transverse lines of mountains. Even the chains, too, often consist of detached groups separated by deep valleys. It is by observing the position of the groups relatively to one another, that the tendency of the chain can be discerned.

Such being the outer barriers of our plateau, there are within it two great ranges mainly parallel, and running from west to east, namely, the Kuen-lun, and the Thian Shan. While the Himalayas form the southern flank of the great Thibetan upland, the Kuen-lun constitutes the northern. The modicum of knowledge possessed by us regarding the Kuen-lun, a most important factor in the geography of our plateau, is largely due to the praiseworthy travels of the Russian Prejevalsky. This range may be said, in a certain sense, to overlook the Tarim basin, ending in Lake Lob, though the mountains are actually distant more than 100 miles from that lake. It forms the southern boundary of the Tarim basin, which contains some of the few beautiful tracts in our plateau. If there be such a thing as a backbone to these regions, or anything like a dorsal ridge, it consists of the Kuen-lun. The Thian Shan starts from the Pamir, and runs westward for full 1,500 miles, till it joins with some of its spurs the uplands of Mongolia proper, or touches with others the dreary desert of Gobi. As the Kuen-lun forms the southern boundary of the Tarim basin, so the Thian Shan constitutes the northern. Connected with the northwestern part of the Himalayas is another range which some regard as an offshoot, but which others treat separately under the name of Karakuram. Together with the Himalayas it joins the Pamir. Thus three of the greatest mountain ranges in Asia converge upon the Pamir, or, according to some, are there interlaced; namely, the Himalayas, the Kuen-lun, and the Thian Shan; to which, perhaps, two others might be added, namely, the Karakuram just mentioned and the Altai. But it may be more accurately said that the outer border of our plateau north of the Pamir is formed by the terminal spurs of the Thian Shan. It is to be remembered, also, that the Indian Caucasus—which does not concern our plateau directly enough to fall within this address—probably joins the Pamir.

In general terms, the convergence of mountain ranges on the Pamir renders it geographically the most important position in Asia. The uninstructed Asiatics have evinced a

hazy admiration of its grandeur by calling it "the roof of the world." The comparatively instructed Europeans have revered it as the source of the classic Oxus, and as fraught with political considerations. Unless further discoveries shall alter existing information, we may expect that completely informed geographers will consider that this Pamir is the mother of mountains, that other ranges are to it as the branches are to the root, and that here, if anywhere, is the true boss of the Asiatic shield. In the second place, the vast surface of our plateau, though almost uninterruptedly environed by its rocky walls, presents an extraordinary series of elevations and depressions. In the heart of the plateau there is the depression known to geographers as the Western Gobi, sometimes called the Tarim basin. Within this there is the Lob Lake or Lob Nor, truly an inland sea, into which the waters of several rivers ultimately flow, finding no vent toward the ocean.

The total length of the Tarim River with its affluents debouching into Lob Nor cannot be less than 850 miles. This curious and interesting lake is not more than 2,000 ft. above sea-level, and forms almost the lowest dip in our plateau. It is like the bottom of a vast platter or the center in the hollow of a mighty hand. Around this depression there are on all sides uplands of various heights like gradations in the Asiatic terrace terminating in the intermediate ranges, or in the circumvallation of mountains already described. On the east of it there is the tract called Eastern Gobi, partly desert, and Mongolia, averaging 4,000 ft. above sea-level; on the north the Altai uplands exceeding 5,000 ft. On the west the Pamir rises abruptly, exceeding 13,000 ft.; on the south Thibet, with equal abruptness, having an average altitude of 15,000 ft. above sea-level, thus being the loftiest expanse in the world; and on the south-east the tract around the Kuku Nor Lake, 10,000 ft.

Further, there is a detached depression known as the Zungarian Strait, extending to the northern confine of our plateau, between the Thian Shan and the Altai ranges. This strait, hardly exceeding 2,000 ft. above sea-level, is as low as, perhaps even lower than, any part of our plateau, and is very near breaking its continuity, which may be considered as being just saved by the comparatively humble altitude above mentioned. The depression is geographically important as forming the only broad pass between our plateau and the world without. It runs from Mongolia, the most important tract within our plateau, to Siberia outside. Great value was, in early times, attached by the Chinese to it, as being the only natural highway on a large scale between Northern and Central Asia.

The existence of this and the other depressions above described has led to interesting speculations among geologists as to their having been in primeval times within our plateau at least one inland sea as large as the Mediterranean of Europe. Be that as it may, there is no doubt that a process of desiccation has been going on within our plateau during historic ages, whereby the climate is considerably affected, and many signs or evidences show that this process is still in operation. On most of its sides our plateau is extraordinarily inaccessible, the passes being steep in the extreme, and culminating in ridges 18,000 to 20,000 ft. above sea-level.

Toward Siberia the Altai passes are easier, and on the north-east, between Mongolia and China, there are several passes that have witnessed the historic outpourings of the Mongol hordes, and which are ominously remembered by the Chinese as the openings through which their invaders rushed like the great river in flood, or the landslip from the mountain side, or the avalanche sweeping along the bowlders and *débris* to the destruction of the valleys beneath. The great desert of Eastern Gobi occupies the eastern portion of our plateau. With its accumulating forces of sand and powdered earth it has a tendency to encroach, and is regarded by man with a vague awe. Its present extent is enormous, being not less than half a million of square miles. Nor does it exist alone within our plateau, for between the Tarim basin and the Kuen-lun spurs there is a lesser desert called Taklamakan with 100,000 square miles of area. It may probably be found that these two deserts join or are otherwise connected. In the third place, we have noted that, while the prevailing characteristics of our plateau are wildness, ruggedness, or desolation, yet within it are the sources of several great rivers which sustain the most teeming peoples on the face of the earth.

The monarch, as it were, of all these noble waters is the Yang-tse-kiang. Though its head streams have been but imperfectly explored, yet its true source is known to be in the Kuen-lun mountains already mentioned. After quitting our plateau and passing out of its prison-house in the mountains through natural gates of the utmost magnificence, it permeates the most thickly-peopled provinces of China—provinces inhabited by about 120 millions of souls. It sustains the life of this enormous population by supplying the necessary moisture, and by affording the means of irrigation and of water traffic. No river has ever in ancient or modern times played so important a part in the increase of the human race as the Yang-tse-kiang. Its supply of water is immense and unfailing, and this most essential characteristic is caused by its connection with the snow-clad and ice-bound regions of our plateau, within which it has a course of 700 miles before entering China Proper. Amid the same Kuen-lun range the Hoang-ho rises from unexplored springs, which the Chinese figure to themselves as "the starry sea." After bursting through several watersheds, making wondrous bends from its main direction near the base of our plateau, and changing its course more than once to the confusion of comparative geography, it traverses Northern China and confers agricultural prosperity on some 70 millions of souls. It also has a course of some 400 miles within our plateau, in consequence of which its water supply is perennially snow-fed.

Again, the Irrawaddy and the Mekhong, the former watering Burmah and the latter watering Cambodia, rise in the off-shoots of the Kuen-lun That region, then, in respect of the parentage of important rivers stands in the first rank. This beneficent circumstance rises from the direction of subsidiary ranges which admit to this part of our plateau some of the moisture-laden breezes from the Pacific Ocean. Similarly, the two Indian rivers, the Brahmapootra and the Indus with its affluent the Sutlej, have their origin at a great distance within our plateau, and their water supply is indefinitely augmented in consequence. Notwithstanding the vast volume of their waters, these rivers play an economic part, which, though great, is much less than that of the main Chinese rivers. The Brahmapootra above its junction with the Megna cannot be said to sustain more than 15 millions of people, and the Indus, together with the Sutlej, may support 12 millions.

The Ganges and Jumna issuing from masses of snow on the southern scarp of our plateau sustain before their junction at Allahabad a population of 30 millions, quite irrespective of the deltaic population of the Lower Ganges, for whom moisture is supplied from other sources. Of these Indian rivers, the waters, perpetually snow-fed, are largely drawn away for canals of irrigation on a grand scale. Taken all in all, despite defects, the Ganges canal is the most imposing example of hydraulic engineering that has yet been seen. From the glaciers of the Pamir and the western terminus of the Thian Shan there spring the head streams of the Oxus, the Jaxartes, and other rivers ending in the inland Sea of Aral. To these, in Persian phrase, the epithet of "gold-scatterer" or "wealth dispenser" is felicitously applied by the natives. Of the rivers rising in the northern section of our plateau, the Amur has possibilities of which the future may see the development. But the great rivers of Siberia, such as the Obi, the Yenisei, and the Lena, though flowing through rich soils and affording marvelous facilities for several systems of inland navigation to be connected with each other, yet have their long estuaries in the permanently frost-bound lands of the Tundra, and their mouths in the Arctic waters frozen during most months of the year. Therefore, they can never, in economic importance, vie with the rivers above mentioned which flow into the Pacific and Indian Oceans.

In the fourth place, the lacustrine system, though not comparable to that of North America, or that of Central Africa, and not approaching in beauty or interest that of Southern Europe, is yet very considerable. It is not, however, the only one in Asia, and from it must be excluded the three great Siberian lakes of Issykkul, of Baikal, and of Balkash, which, though connected with our plateau, are beyond its actual limits. Exclusive of these, however, the lakes, great and small, within our plateau are extraordinarily numerous. Not less than a hundred of them may be counted on the maps of this region. Of these lakes, however, some are insignificant, being little more than saline swamps. Others, again, as the Pangong, though romantically beautiful—reposing at an altitude equal to that of the highest European mountains, and reflecting the perennial snow of surrounding peaks—do not illustrate specially any geographical problem, nor produce any economic result. But some may be selected as having a scientific interest, irrespective of beauty or of strangeness.

The Lake Victoria, discovered by Wood in 1838, rests in the heart of the Pamir, already mentioned, at an elevation of 14,000 feet above sea-level. It is frozen over during the greater part of the year, and lies with a glistening and polished surface in the midst of a snow-whitened waste. In that state it powerfully affects the imagination of the spectator who reaches it as the final goal, after a protracted and toilsome ascent from the barren or deserted plains of Ariana. It is the source of the Oxus, and is near the point of contact between the British and the Russian political systems in Asia.

In the sharpest contrast to the highly-placed Pamir lake is the lowly Lake Lob, already mentioned. Shallow water, sedgy morass, dreary sands, parched forests, the monotony of desolation, are reported to be its characteristics. It apparently consists of the dregs of an inland sea that is mostly dried up, and is, as it were, kept alive only by the Tarim River, which has its sources in the everlasting snows of the Pamir. Despite the proximity of saline tracts, the lake has fresh water. Near it is a great desert, of which the soil, though now arid and friable, owing to the gradual desiccation, was once more or less productive, and where a population has probably become extinct or has disappeared by migration.

The Pamir, then, is a water-parting for two inland seas, one the Aral, beyond our plateau, the other Lob Nor, within it—both saved from speedy desiccation only by the influx of rivers from the snow-line. Again, in contrast is the Kuku Nor, a sheet of water 10,000 feet above sea level, in the eastern section of the Kuen-lun mountains near the source of the Hoang-ho. Its waters, profound and saline, have a dark azure hue, which is compared by the natives to that of the exquisite silks in China. It is in the Tangut region, mentioned by Marco Polo in his "Itinerary." In respect to the lakes in this region, and especially the morasses of Tsaidam, there are geological speculations as to another Asiatic Mediterranean besides that already mentioned, long since dried up, whereof there are a few widely-scattered remnants, among which the Kuku Nor is one.

Lastly, a word of passing notice may be devoted to two among the Thibetan lakes, that of Tengri, near Lhassa, on the shore of which stands a venerated Buddhist convent, and the Bul-tso, from which have been obtained quantities of the best borax. In the fifth place, the northeastern part of our plateau was during remote ages beyond the ken of history the home of hardy and aggressive Tartars. These Tartar races, dwelling among the uplands in the lee of the mountains, used for many centuries to emerge and harry the fertile Chinese plains lying between the mountains and the Pacific Ocean.

It was to ward off these incursions that the Great Wall was constructed, winding like a vast serpent of stone along the ridges of mountains for 2,000 miles from the Pacific coast to the Siberian confines. The cost and labor expended on this amazing work attest the dread with which the Tartar highlanders had inspired the Chinese lowlanders. Some centuries after the building of the wall, the most warlike among the Tartar tribes, in the council of their national assembly, acclaimed Temujin as their king, in the year 1,206 A.D. He took a title, which is translated by Europeans as Chinghiz Khan, a title which for two centuries or more was the best known name in the whole world. At the head of his Tartar adherents, he first subdued the other kindred tribes of our plateau. Then he organized and disciplined the whole Tartar manhood into an army of horsemen. This is the most wonderful instance of military mobilization known to history, ancient or modern. Its results, too, were equally appalling.

In mediæval times the marches of the Arabs and the Saracens, in modern times the expeditions of Napoleon, have dazzled Asia or Europe. These were hardly, however, equal to the distant conquests of Alexander the Great in ancient times. But even the wars of Alexander were, perhaps, surpassed by the ravages of Chinghiz Kahn and the Tartars of our plateau. The countries of China, India, Afghanistan, Bactria, Persia, the Aral-Caspian basin, Siberia, Asia Minor, Russia, were overrun within a hundred years by Chinghiz Khan, his lieutenants, and his immediate descendants. Thus, through the hordes of our plateau, there was established a dominion stretching from Cape Comorin, near the equator, to the Arctic Ocean, and from the Pacific shores to the banks of the Vistula in Poland.

The latest historian of the Mongols considers that nothing but the unexpected death of the Tartar sovereign, and the political combinations arising in consequence within this very plateau of ours, prevented the Tartar invasion from spreading even to Western Europe. Though it is often held that these terrific events have been overruled by Providence for the progress of mankind, still at the time they caused what Gibbon truly calls a shipwreck of nations.

Notwithstanding this, the Tartars won, in a certain sense, an unparalleled success, which is attributable to the geographical circumstances of our plateau. The influence of the precipices, the forests, the prairies, the wild sports, in forming the national character, is so obvious that it need not be specified. We readily understand how the sturdy mountaineer, the daring hunter, the practised archer becomes the able soldier. In Mongolia, however, the local specialty was this: that the practically boundless extent of the pasturage, and the nutritious richness of its quality, induced the people to maintain countless horses, cows, buffaloes, sheep, goats, and camels, neglecting the tillage of the soil, never building houses, but living in tents made of warm felt, accumulating a certain sort of rude wealth, still roving and roaming about at some seasons incessantly from one encampment or one grazing ground to another, dragging with them their families and their effects, by means of the pack animals and the roomy wagons, drawn by many oxen yoked abreast. Thus was a truly nomadic existence practiced on the largest scale ever known. Mongol armies, better drilled, armed, accoutred, and equipped than any forces then known in the civilized world, would emerge from our plateau into the inhabited plains around, and would observe houses and towns for the first time. It is even alleged that some of them had never seen cultivated crops before. In this state of existence, the temptations to depredation of all sorts were excessive, and the danger from the climate, the savagery of nature, and the wild beasts was always imminent. Consequently, the Mongols were obliged to hold themselves together by the cohesion of families, clans, and tribes. Thus, by the force of circumstances, a social organization was established which proved the foundation of a military discipline suitable to the genius of the people, almost self-acting, and unfailing even in the remotest expeditions. The horses, too, upon which the Mongol warriors mainly depended, naturally fell into the training; being always turned out to graze in herds, they habitually kept together, and the field maneuver fixed habits which had been already acquired. It used to be remarked that a line of Mongol cavalry was like a rope or a chain—perfectly flexible, but never parted. The Mongolian food included little of cereals or vegetables, but consisted mainly of cheese and meat. For stimulating drink there was the fermented mare's milk. The name "koumis," or "prepared milk," apparently much esteemed medically now-a-days, is a Mongolian word. Manifestly, men thus nurtured could live in the saddle day and night, carrying with them their sustenance in the smallest compass, and scarcely halting to eat or drink. Thus the hardihood evinced on protracted marches, which would otherwise be incredible, can be accounted for. It is probable that this diet, while sustaining vivacity, produced also a violence of disposition. Certainly, ruthlessness, cruelty, indifference to suffering, characterized the Mongols, and marred the effect of their grand qualities. Massacres, holocausts, conflagrations marked their warlike operations. Even famines and epidemics have hardly done more for depopulation than the Mongol conquests. A Mongolian chief would say that the keenest enjoyment in life was to stamp upon a beaten enemy, to seize his family, and despoil his encampment. It is not the purpose of this address to describe the policy of the Mongols or the institutions which they founded in conquered countries.

A few salient points only have been indicated in reference to the geography of our plateau. It is here, near what is now known as the upper region of the Amur, that the Onon, the Orkhon, and the Kerulen, classic streams in Mongol story, take their source. Here is the site of Kara Koron, the Emperor's headquarter encampment. Here the Kurultai assemblies were held to decide the fate of nationalities. Here were the camps, the Urts, and Urdus, rude names, at first unpronounceable in the civilized world, but soon to become terribly familiar. Here were the hordes mustered under their banners, each standard having its distinctive color, the supreme ensign being, however, the yak's tail raised aloft. Hither, also, the corpse of Chinghiz Kahn was borne in a cumbrous catafalque, dragged through the deep loam by oxen yoked twenty abreast, while his henchmen chanted a dirge which was a pathetic effusion from the heart of a valiant nation, and was full of poetic images drawn from the Mongolian surroundings.

In the sixth place, though our plateau has possessed, and still possesses, some patches of fine cultivation, such as those in the Upper Tarim basin, near Yarkand and Kashgar, and some near Lhassa, in Thibet, still it has comparatively but little of agriculture, of trade, or of industry. Nevertheless, it has many natural resources of value and interest, while its pastoral resources have proved astonishing. Its breed of horses, though by no means the finest, has yet been quite the largest ever known. These horses have never displayed the beauty of the Arabian, or the size of the Turcoman breed. They are middle-sized, and do not attain the speed of thoroughbreds. But in nimbleness amid rugged ground, in endurance over lengthened distances, and in preserving their condition with scanty nourishment, they are unrivaled. Their numbers, too, may well exercise the imagination of modern breeders. For many years the Tartar emperors maintained in the field at least 500,000 cavalry, for which the horses were drawn chiefly from our plateau. This enormous cavalry force was engaged in fighting over an area of many thousand miles in length and breadth, during which operations much desperate resistance was encountered. It was occupied in steep ascents and descents, in traversing deserts, in crossing frozen lakes, in swimming rapid rivers. How vastly numerous, then, must have been the casualties among the horses, and how immense the breeding studs. The pasturage, too, was so potent in nutritive qualities that ordinarily there was risk of animals suffering from repletion, and emaciated creatures rapidly gained flesh and strength. In other respects, too, the fauna are noteworthy—the sheep and goats, with wool or down of the softest texture—the buffalo herds and the yaks, inured to the sharpest cold—the gazelles, careering in thousands—the untamable camel of the desert, having a speed and agility unknown in other species—the wild asses and the white wolves—the water-fowl, at times like clouds darkening the air. The flora, too, though less abundant, has its specialties—the pointed grasses, sharp enough to pierce leather, the gigantic rhubarb, the magnificent holly, the branching juniper.

The mineral resources of the Kuen lun are certainly enormous; nobody yet knows how great they may prove. Indeed, our plateau is remarkable for the antimony, the sulphur, the saltpeter, the borax, the gold-washings, the turquoise, and the classic jadestone. In the seventh place, the field offered by our plateau for scientific research will be apparent from even a cursory consideration of the stage to which our knowledge has reached. From the second of the two diagrams, which shows in deep pink those portions of Asia that have been professionally surveyed, in light pink those

that have been roughly surveyed, in lighter pink those that have been explored only, and in white those that are unexplored, it will be seen that almost the whole of our plateau is unsurveyed, and that while much of it has been explored more or less, some portions yet await exploration. For some time, however, it has been the sphere chosen by many among the most skillful, enduring, and intrepid travelers of Europe.

The journeys of the Russian Prejevalsky in the Tarim basin and Mongolia, of Potanin and Rafailoff, in the same region, of Malussovski, near Kobdo, of the French missionaries Gabet and Huc in Mongolia, of the Bishop Desgodins in Thibet, of the German Schlagintweit in Turkestan, of the Englishmen Forsyth, Trotter, Johnson, Shaw, Hayward in the Tarim basin, of Wood in the Pamir, of Ney Elias in Mongolia, of Delmar Morgan in Kulja, of Bogle and Manning in Thibet, while teaching us very much, have yet left our minds dazed with a sense of what remains to be learnt. Even the trigonometrical determination of the Himalayan summits by the English Surveyors-General—namely, Everest, Waugh, and Walker—the researches of Basevi, Stolicska, Godwin-Austen, Thomson, Biddulph in the same quarter, and the Siberian surveys by the Russians among the Altai and Tian-Shan mountains, have brought us to the verge of half-discovered or undiscovered countries.

The greatest unexplored region in all Asia—namely, the Kuen-lun range—lies in the very heart of our plateau. It is remarkable, too, that if the principal geographical problems awaiting solution in Asia be specified, such as the true and ultimate sources of the Hoang-ho, the Irrawaddy, the Salwin, the Mekhong, the relation of the San-po with the Brahmapootra, the connecting links between the Kuen-lun and the Chinese mountain chains, they will be found to concern our plateau. At a few points only has our plateau been penetrated by geological surveys—namely, in some parts of the Altai and at the western end of the Thian-Shan; and these surveys are Russian. But the formations, the strata, the upheavals, the denudations, the fluvial action, awaiting scientific examination are indescribably great.

A notion of some of the questions inviting inquiry from the geologist and palæontologist may be gathered from what has been already said under previous headings in respect to the general desiccation and the subsidence or evaporation of the primeval waters. To the naturalist, few regions present more surprising opportunities for the observation of the coming, the resting, the departing of migratory birds. To meteorologists, many of the natural phenomena must prove highly interesting—the causation of the wondrous dryness, the effects produced on animal comfort by the rarefaction of the air, the mummified bodies, dried up without undergoing putrefaction, the clouds of salt particles driven along by furious gusts, and filling the atmosphere, the fires in the parched vegetation of the desert, the spontaneous ignition of coal-beds, the caves emitting sulphurous gases, the rock girdle of syenite bounding the Gobi desert, the gradual contraction of the glaciers, the ordinarily rainless zones sometimes invaded by rain-storms with a downpour like that of the tropics. In the eighth place, our plateau is now under one imperial jurisdiction, and offers many problems for social inquirers. It belongs entirely to the Chinese empire, with the exception of one small tract where the Russian authorities have crossed the mountain border.

The geographical features, for the most part, favor national defense and territorial consolidation. The old Chinese Wall is still suitable to the political geography of to-day. In the Zungarian strait, however, in the Ili valley, near Kulja, perhaps, also, in the line of the Black Irtish, near Zaisan, the Chinese empire, in its contact with Russia, has weak points strategically, or chinks in its armor. Though the plateau was originally under Chinese suzerainty, it became, under the Mongolian emperor Chinghiz Kahn and his successors, the mistress of China, as, indeed, of all Asia and of Eastern Europe. As the Mongol power, however, shrank and withered, the Chinese reasserted themselves. At length, under a dynasty from Manchuria, outside the mountain border, the Chinese became lords over our plateau. The Zungarian tribe of Eleuths rose, and, after severe military operations, were suppressed. The Mohammedan inhabitants of the Tarim basin rebelled against the Chinese government, and for a while maintained an independent principality for Islam. It was during this time that the British sovereign sent an envoy to Yarkand to conclude a commercial treaty, in 1873. Subsequently, the Chinese broke down this rising independence, and the whole region of the Tarim receives its orders from the emperor at Pekin.

The decline and fall of the Mongol empire, the disruption of that widespread dominion, like the breaking up of the ice on its own frozen rivers, are historical themes beyond the scope of this address. But the changes which have gradually come over the national character of Mongolians are cognate to the studies of geographers. As already seen, the annals of the Mongols reveal one of the many examples of the theory of causation, explaining how geographical surroundings mould or affect the human character. There remain the mountains, the sea of undulating uplands, which are still among the few important regions not essentially modified by human action. The pine forests, though hardly intact, have not been extensively cleared. There is the dread desert—where, to the ears of superstitious Mongols, the roll of the mustering drums and the shouts of victorious battle are audible—and which has ingulfed in sandy waves additional tracts once productive. The pastoral resources, the nomadic diet and exercises, the tribal organization, are in kind the same as of yore, though perhaps modified in extent or degree. The short-lived heat may, perhaps, be gaining strength as the ages advance; but the winters must be nearly as long and hard as ever.

Thus the same physical and climatic conditions, which once caused the Mongolian nation to become one of the mightiest engines ever directed by man, are still surrounding the politically degenerate Mongols of to-day, who are best represented by the tribe of Khalkas. Once audaciously ambitious, the Mongols are now sluggish and narrow-minded; once passionately fond of an independence as free as their mountain air, they are now submissive to the domination of races formerly despised by them as inferior; once proud of a tribal organization and a voluntary discipline that wrought world-renowned wonders, they are now split up into factions like a fagot of sticks that has been unbound. A man who, though the feeblest of pedestrians, gripes with his bowed legs the saddle of the most restive horse as with a vice, is all that remains of the historic Mongol.

It is for the social inquirer to determine what have been the circumstances counteracting the climatic and local causes which made this nation potential in moulding mediæval history. Here, too, may be observed the tendencies of Paganism, Buddhism, and Mohammedanism respectively. Of all regions, our plateau offers the best means of studying Buddhism, which still counts more adherents than any other faith. Though the mid-Ganges Valley was the birthplace of this widespread religion, and was for ages regarded by pious Buddhists as their holy land, yet during recent centuries the active center of the faith has been in Thibet. Of the four incarnations of Buddha now held to exist, three are within our plateau—namely, two in Thibet near Lhassa and at Teshu Lumbo, and one in Mongolia, at Urga, near the spot where mounds attest the burial of heaps of slain, after one of Chinghiz Kahn's earliest battles. In Thibet may be seen to the best advantage those religious ceremonies, the sight of which has always attracted the observation of Roman Catholic missionaries.

In conclusion, this brief summary of our geographical knowledge regarding the plateau of mid-Asia is provisional only, for it avowedly deals with regions most unsurveyed, and seldom even explored completely. Further exploration or discovery, therefore, may reverse some of our specific conclusions, or may modify the current of our topographical ideas. It is probable, indeed, that there will be such changes, inasmuch as almost every investigation within this vast area has revealed something unimagined before, or has caused disbelief of something previously believed. This address, then, is limited to a *résumé* of things imperfectly known, with a view of bringing into strong relief two matters which are unquestionable—namely, the importance of our plateau and the grand field it offers for research. If the public consideration of these matters shall induce inquirers to direct their enterprise toward this grand region, we may hope that by degrees the errors in our facts may be removed, the misdirection of our conclusions remedied, the vagueness of our notions made definite. At present the physical obstacles in the path of such inquiries are so grave as to be almost deterring. But they do not finally deter those who, after forethought, decide to brave peril, distress, sickness, suffering, in order to enlarge the bounds of knowledge. Each inquirer, however, has the consolation of reflecting that he makes the rough ways smoother for those who shall come after him. Every journey that is accomplished must facilitate successive discovery in the same line of country. Probably as fast as one line is made good, geographically fresh lines may present themselves, and new vistas will be opened to the astonished gaze of geographers. At length, with all the constancy and courage which arduous travel never fails to inspire, the inquirers of the future will doubtless explore this plateau till it becomes as well known as the Alpine regions of Europe.

CHIEF DEITIES IN AMERICAN RELIGION.

AT the recent meeting of the American Association, a paper was read by Mr. A. S. Gatschet, the subject being the "Chief Deities in American Religion." He said:

"The religions of all tribes discovered in North and South America belong to the category of spirit worship mixed with some lower or higher degree of anthropomorphism. Their deities are clearly nature gods, their worship is not a *cult* intended for merely improving the worshiper, but is propitiation, and propitiation is only another form of human egotism. The majority of these gods are austere, cruel, and remorseless for their present objects and powers of nature, and like these they show no moral or sentimental aspects like monotheistic deities. At the time of their discovery, and a long time after it, many American tribes, although possessed of religion, seem to have had no priest, no ceremonial rites, no religious festivals, sacrifices, or temples, and this induced some travelers who were unable to communicate in their own language and had not remained long enough to study their customs and ideas with becoming thoroughness to deny the existence of any sort of religion among them. Had they inquired for the burial customs, they would at once have detected a belief in a future life, and such a belief is inseparable from religious ideas. A close examination of the initiation rights would have revealed the fact that most of these customs are of a religious character, the term religious to be understood, of course, in a more comprehensive sense than the one the Christian attaches to it.

"The best term to depict the real essence or quality of American religion is not that of polytheism, but the one of polydaimonism, which means the worship of many spirits. In the motley crowd of ancient and new gods in American religions, a few only rise to general prominence, and among these few one is considered as the principal deity. The chief god is not always the most popular deity among men, but he is regarded as the most powerful among the gods, many of whom are found to be antagonistic to his rule. Chief deities represent a combination of several powers of nature united into one body. In the mythic stories of the people, this chief god is sometimes the most frequently spoken of; at other times he is placed in the background by one or two more brilliant and therefore more popular creations of the aboriginal mind, and if his obnoxious or terrific qualities make him less attractive to man, his irresistible power will leave him the object of intense dread."

The paper proceeded to investigate the chief deities of South, Central, and North America of which we have any knowledge that is more than superficial. Among them may be mentioned the Botchika of the Muisca people, U. S. of Colombia, the Viracocha or "water foam," and the Inti of the Peruvians, the Tezcatlipoca, or the "shining mirror" of the Aztecs of Mexico, the Amotkan of the Selish, of Washington Territory and British Columbia, the Manibozko among the Ojibbeways. These gods were all found to be solar gods, while other deities of the same nations appearing in their mythology as rivals to the sun gods or lunar gods, the most conspicuous of them being Quetzalcoatl of the Aztecs. In looking over the large number of native American sun myths, investigators are induced to prove the opinion of the Jesuit Father Lafitau, who wrote in 1724:

"The sun is the divinity of the natives of America, without excepting any of those with whom we are acquainted. The more tribes we explore, the more we increase the number of men known to be sun worshipers, but through this inquiry another important result may be gathered with the majority of all tribes worshiping the sun, regarding the sun deity as their chief deity."

This the author of the paper claims to be the principal and highly important conclusion derived from his researches on the subject, and it is only the imperfect state in which tribal mythology is generally brought to our knowledge that hinders us from pushing on our inquiries in this direction. The only mode of getting at the real meaning of Indian myths, is to take them down from the myth tellers in their Indian language, and obtain a careful translation of their texts.

ABOUT 1,500 miles of new railroad were put into operation in the Southern States last year. The gross earnings of Southern roads reached $63,000,000, and the net earnings increased from $18,000,000 in 1880 to more than $24,000,000.

A LARGE MASTODON'S SKELETON.

THE remains of an immense mastodon of most incredible proportions were discovered to-day at Paris, Ky. A number of negro men at work on the extension of the Kentucky Central about two miles from town came upon the skeleton or bones of some immense animal about ten feet under ground, in a soil of steatitic nature. The first discovered was the ankle, which, on being measured, showed a diameter of seven inches. Following up this bone, they discovered the knee, which, through the socket, was twelve inches in diameter. From the ankle to the top of the shoulder-blade—it being three feet two inches wide—was fourteen feet seven inches. The head was of large proportions, measuring five feet in length and several in width. The jaw was twelve inches thick, and the teeth are preserved in good condition. The backbone was then followed up, and forty feet from the head were the bones of the tail. The hindquarters were exceedingly large, measuring in height twenty-three feet eight inches. The hipbone was ten and a quarter inches thick. The teeth on being weighed proved each to be two to three pounds. Altogether it is the most astounding curiosity ever known in this community, and enough of the remains are still in good condition to prove the truth of the assertion. It is to be regretted that the remains could not be taken out entire.—*Lexington (Ky.) Dispatch to Louisville Courier-Journal, October 2.*

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